MARYLAND
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BALTIMORE
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Also with the coöperation of several members of the scientific bureaus of the National Government.

LETTER OF TRANSMITTAL

To His Excellency AUSTIN L. CROTHERS,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith a report on The Physical Features of Prince George's County. This volume is the sixth of a series of reports on the county resources, and is accompanied by large scale topographical, geological, and agricultural soil maps. The information contained in this volume will prove of both economic and educational value to the residents of Prince George's County as well as to those who may desire information regarding this section of the State. I am,

Very respectfully,

WM. BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE, *March, 1911.*

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ILLUSTRATIONS

PREFACE

This volume is the sixth of a series of reports dealing with the physical features of the several counties of Maryland.

The *Introduction* contains a brief statement regarding the location and boundaries of Prince George's County together with its chief physical characteristics.

The Physiography of Prince George's County, by Benjamin L. Miller, comprises a discussion of the surface characteristics of the county, together with a description both of the topographic forms and of the agencies which have produced them.

The Geology of Prince George's County, by Benjamin L. Miller, deals with the stratigraphy and structure of the county. An historical sketch is given of the work done by others in this field to which is appended a complete bibliography. Many stratigraphical details are presented, accompanied by local sections.

The Mineral Resources of Prince George's County, by Benjamin L. Miller, deals with the economic possibilities of the various geological deposits of the county. Those which have been hitherto employed are fully discussed, and suggestions are made regarding the employment of others not yet utilized.

The Soils of Prince George's County, by Jay A. Bonsteel, contains a discussion of the leading soil types of the county and their relation to the several geological formations. This investigation was conducted under the direct supervision of Professor Milton Whitney, Director of the Bureau of Soils of the U. S. Department of Agriculture.

The Climate of Prince George's County, by William H. Alexander, is an important contribution to the study of the climatic features of the county. Mr. Alexander is Section Director in Baltimore of the U. S. Weather Bureau, and is also Meteorologist of the Maryland State Weather Service.

The Hydrography of Prince George's County, by F. H. Newell, gives a brief account of the water supply of the county, which, as in the case of the other Coastal Plain counties, affords but little power for commercial purposes. The author of this chapter is Director of the U. S. Reclamation Service.

The Magnetic Declination in Prince George's County, by L. A. Bauer, contains much important information for the local surveyors of the county. Dr. Bauer has been in charge of the magnetic investigations since the organization of the Survey and has already published two important general reports upon this subject. He is the Director of the Department of International Research in Terrestrial Magnetism of the Carnegie Institution.

The Forests of Prince George's County, by F. W. Besley, is an important contribution and should prove of value in the further development of the forestry interests of the county. Mr. Besley is State Forester of Maryland.

The State Geological Survey desires to extend its thanks to the several national organizations which have liberally aided it in the preparation of several of the papers contained in this volume. The Director of the U. S. Geological Survey, the Chief of the U. S. Weather Bureau, the Chief of the U. S. Forest Service and the Chief of the Bureau of Soils of the U. S. Department of Agriculture have granted many facilities for the conduct of the several investigations and the value of the report has been much enhanced thereby.

THE

PHYSICAL FEATURES

OF

PRINCE GEORGE'S COUNTY

THE PHYSICAL FEATURES OF PRINCE GEORGE'S COUNTY

INTRODUCTION

Prince George's County lies between the parallels 38° 32′ and 39° 8′ north latitude and the meridians 76° 40′ and 77° 5′ west longitude and, with Anne Arundel, Charles, St. Mary's and Calvert counties, comprises what is commonly known as Southern Maryland. It covers an area of 479.6 square miles. The county is separated on the north and east from Howard, Anne Arundel and Calvert counties by the Patuxent River; on the south from Charles County by Swanson and Mattawoman creeks and a line between them; on the west from Alexandria and Fairfax counties, Virginia, by the Potomac River, and from Montgomery County and the District of Columbia by arbitrary lines. The lower portion of the county forms a part of the Southern Maryland peninsula, situated between the navigable estuaries of the Potomac and Patuxent rivers, while the northern part connects the peninsula with the upland. The county thus includes portions of two geological provinces, the Coastal Plain and the Piedmont Plateau.

The earliest settlements in Prince George's County were made upon the Patuxent side of the County in the vicinity of Mataponi Creek, from which point to Swanson Creek stretched a more or less scattered plantation close to the river banks. The earliest records show that the inhabitants along the river were regarded as living in St. Mary's County. In 1650, when old Charles County was erected, the south shore of the Patuxent was included in it and such settlements as were made within the present limits of Prince George's

County were under the immediate control of Robert Brooke, Commander of old Charles County. In 1654 old Charles County was abolished and the territory on both sides of the Patuxent was erected into Calvert County. Somewhat later Calvert County was limited to the territory on the eastern side of the Patuxent and Prince George's County became part of the new Charles County which was erected in 1658. This was the condition of affairs up to the general act of 1695 when Prince George's County was erected. It was then enacted:

"that the Land from the upper side of Mattowoman and Swansons Creeks & Branches Extending upward bounded by potomock on the West and Patuxent River on the East shall be and is hereby Constituted founded & Incorporated into a County of this Province and shall be Denominated Called and known by the name of Prince George's County and shall from and after the said Twenty third day of Aprill next Ensueing being St. George's Day as aforesaid have and enjoy all other Rights benefitts and priviledges Equall with the other Countys of this Province such as sending Burgesses to Assemblys haveing County Courts Sherriffe Justices and other Officers and Ministers requisite & necessary and as used in other Countys of this Province."

At the time Prince George's County was erected there were settlements along the Patuxent nearly up to Laurel, but there were few, if any, settlements on the Potomac side in the vicinity of Piscataway Creek on account of the presence of the friendly Indians, who had reserved to themselves this territory for a permanent abode. There were, however, settlements or small outposts at the mouth of Rock Creek within the present limits of Georgetown and along the Anacostia River in the vicinity of Hyattsville and Bladensburg, and as far up the Northwest Branch as the present Montgomery line.

Within the next two decades these settlements had extended beyond the present limits of Prince George's County although they were at that time within its limits. During these same years the whites began to settle on the territory formerly claimed by the Indians.

The first curtailment of territory affecting Prince George's County occurred in 1748 when it was reduced to its present limits, plus the District of Columbia, by Chapters 14 and 15 of the Laws of Maryland for 1748. According to the first act, which was stimulated by a petition of some of the freeholders in Prince George's County who found it inconvenient to attend the County Court at Upper Marlboro, it was enacted:

"That from and after the Tenth Day of *December*, in the year One thousand seven hundred and forty eight the Land lying at present in *Prince George's* County, and contained within the bounds following, viz., by a Line that leads from *Mattawoman* run, in the Road commonly called the *Rolling Road*, that leads from the late dwelling Plantation of Mr. *Edward Neale*, through the lower part of Mr. *Peter Dent's* Dwelling Plantation, until it strikes Patowmack River, at or near the bounded Tree of a Tract of Land whereon *John Beall*, junior now lives (standing on the Bank of the aforesaid River, at the lower end of the aforesaid *Beall's* Plantation) then with the River to the Mouth of *Mattawoman* Creek, shall be and for ever hereafter deemed as a Part of *Charles* County. . . ."

The second act passed in 1748 related to the erection of Frederick County from all the less settled portions of Prince George's County. According to this law it was enacted:

"that all the land lying to the westward of a line beginning at the lower side of the mouth of Rock Creek and thence by a straight line joining to the east side of Seth Hyatts plantation, to the Patuxent River should be taken from Prince George's County and made into a new jurisdiction to be called Frederick County."

The final change in the boundaries of Prince George's County was made in 1791 when the District of Columbia was ceded to the National Government from portions of Montgomery and Prince George's counties.

Agriculture is the principal occupation of the inhabitants of Prince George's County. At one time or another practically every acre of ground, except on the steep slopes along the streams, has been under cultivation. The urban population is, however, on the increase and the small towns along the railroads and trolley lines are rapidly growing. In the vicinity of Washington truck farming is carried on extensively and the farms are generally of small size. In the southern portion of the county tobacco is the most profitable crop, while elsewhere corn and wheat are the principal products.

The manufacturing interests of the county are neither extensive nor varied. A woolen mill which has been in operation a great many years is located at Laurel, while minor manufacturing interests of various kinds are carried on in the small towns of the region.

DEVELOPMENT OF KNOWLEDGE CONCERNING THE PHYSICAL FEATURES OF PRINCE GEORGE'S COUNTY, WITH BIBLIOGRAPHY

BY

BENJAMIN L. MILLER

Introductory.

Since 1608, when Capt. John Smith ascended the Potomac River to the falls above Georgetown this region has attracted the attention of explorers, travelers and geologists, many of whom have published their observations. The proximity of the national capital has brought many geologists to the region during the past century and consequently the literature is more extensive than that of any other county in the Coastal Plain of Maryland.

In this review no attempt is made to include all who have written on the geology of the region, but only those who have rendered most service in advancing our knowledge of the geology of the area, consequently investigators are mentioned rather than collaborators. The bibliography which follows gives the names of both. A brief chronologic resume is followed by a discussion of the development of knowledge of each of the different groups of formations.

Historical Review.

1612-1809. All of the early work in Prince George's County was of an exploratory character, and the published descriptions contain such general statements that in most instances it is impossible to tell exactly what regions were visited. The most important publications of this period are those of Capt. John Smith, which appeared in 1612 and 1624.

1809-1830. Although previous writers had casually referred to the gravels, sands and rocks of the Coastal Plain, not until 1809 were any strictly geological investigations published. Between 1809 and 1830 Maclure, who is sometimes called the "father of North American geology," published several general articles on the geology of North America which served to stimulate investigation, while other geologists noted the occurrence of minerals and fossils at various localities.

1830-1880. In the next period investigations were confined almost entirely to the study of the fossils which are so abundant in the Cretaceous and Tertiary formations and to discussions of the age of the fossiliferous deposits. While many erroneous conclusions were reached by certain investigators, the work in general was carefully done and formed the basis for subsequent investigations. The publications of Conrad stand out most prominently during this period. Morton, Bailey and Leidy also made valuable contributions to the geology of the Coastal Plain during this period while Ducatel, Alexander and Tyson, although their work was not as important as that of the investigators previously mentioned, advanced the knowledge of the geology in no inconsiderable degree. These last three men were principally concerned in the exploitation of the economic resources of the region yet they made good use of the results obtained by other workers and helped to spread the information. By 1880 nearly all of the broader divisions of the geological time scale had been recognized and many tentative correlations had been made with the geological formations of other regions.

1880-1908. Since 1880 many important publications have appeared. The work of previous investigators has been critically examined; definite lines of separation between the different formations have been determined; numerous subdivisions have been made as the result of detailed stratigraphic and paleontologic work; and important correlations have been established. In addition monographic studies have been made on some of the formations represented in the region. The publications of Clark, McGee, Darton, Ward, Shattuck and Martin are of primary importance during this period.

GENERAL CONTRIBUTIONS.

Maclure, in 1809, was the first geologist in this country to attempt to separate the different kinds of rocks on the basis of lithologic differences. These divisions were termed formations. He noted the wide difference in the characters of the rocks composing the Piedmont Plateau and the Coastal Plain and on the basis of these differences established two formations. He called the crystalline rocks of the Piedmont Plateau the "Primitive formation," and the unconsolidated deposits of the Coastal Plain the "Alluvial formation." His conclusions, accompanied by a colored geologic map on which these divisions were represented were published several times but most fully in 1817. The work of Maclure served as a great incentive to geologic research in this country outlining as it did the methods of work which have been followed since his time and which have yielded such important results.

Ducatel, State Geologist of Maryland from 1834 to 1840, was the first person to publish any definite information of value concerning the geology of Prince George's County. In his first report, published in 1834, he refers to the fossiliferous deposits at Upper Marlboro and Fort Washington and discusses the economic value of the marls and iron ore of the county. He elaborates upon the same subjects in his report for the year 1835, and in his 1836 report (published 1837), he again calls attention to the shell and greensand marls occurring within the region, which he thinks might prove valuable as fertilizers. In the latter publication he discusses the physiography and geology of Prince George's County in a more detailed manner than had any of his predecessors.

The reports of Alexander, the Topographical Engineer, issued in connection with the reports of the State Geologist, contain many good descriptions of the physical features of the county. In his "Report on the New Map of Maryland, 1835" the characteristics of Piscataway Creek are discussed and profile drawings of it are included in the report. He described the manner in which the creek was being filled by sediment brought in by tributary streams and discussed the feasibility of constructing canals along either side of the creek to receive the surface drainage and thus keep the stream navigable.

Tyson, State Agricultural Chemist, in his two reports to the House of Delegates in 1860 and 1862, described the mineral resources of Prince George's County, mentioning particularly the deposits of iron ores, marls, and tripoli earth.

In 1892 Clark, in his article on "The Surface Configuration of Maryland," gave many facts pertaining to the topography of Prince George's County. In the following year Williams and Clark brought together in the volume "Maryland, Its Resources, Industries and Institutions," all that was then known in regard to the physical features, geology and mineral resources of the State, while in 1897 Clark, in Volume I of the Maryland Geological Survey, contributed a more detailed report on the same subjects. These reports contain brief descriptions of all the geological formations of the County then recognized, and much information regarding the physical features and economic resources.

Another important publication to be mentioned is "The Washington Folio" of the United States Geological Survey by Darton and Keith. The area described includes all of the District of Columbia and a large part of Prince George's County and was the most complete work on the geology of the region published up to that time. Each of the geological formations, differentiated, is described and its relation to the other formations discussed.

A similar work, "The Patuxent Folio," by Shattuck, Miller and Bibbins, published in 1907 by the United States Geological Survey, contains more detailed information of the physiography, geology, and mineral resources of the region than had previously been brought together in one publication. The area covered by the Patuxent folio includes a portion of the District of Columbia and all of Prince George's County except small areas in the northern and southwestern portions. The classification of the formations there used is the same as that recognized in this report.

HISTORICAL REVIEW OF THE VARIOUS GEOLOGIC GROUPS.

The Crystalline Rocks of the Piedmont Plateau.—Until within recent years geologic literature contained very few and brief descriptions of the crystalline rocks of this region, and at the present time

the literature on the subject is still scanty. The earliest reference is found in a work by Martin entitled "A Comprehensive Description of Virginia, and the District of Columbia," published in 1835, in which is given a brief description of the gneiss in the vicinity of Rock Creek. Featherstonaugh in an article published in the following year also refers to the gneiss of that region and states that it dips to the east. Merrill in 1884 was the first geologist to describe the crystalline rocks in any detail. Additional brief information is given in articles by the same author published in 1886 and 1895.

Williams, in 1891, in "Geology of Washington and Vicinity," was the first to differentiate and describe the leading rock types occurring in the vicinity of Washington and to explain their general structure. The best and most complete account of the crystalline rocks of this region is contained in "The Washington Folio" already mentioned. In that publication Keith describes all the different kinds of crystalline rocks of the District of Columbia and some of those of Prince George's County. The data for the descriptions of the crystalline rocks included in this report are principally taken from the Washington Folio.

The Lower Cretaceous.—The first published statement regarding the materials of the Potomac formations is contained in a book by Finch on "Travels in the United States of America and Canada," published in 1833, in which reference is made to the red soils exposed in ravines between Bladensburg and Washington. The iron ores of the County which occur in deposits of this age were described by Ducatel and later by Tyson. A great advance in our knowledge of these formations was made by Rogers in 1875, who published a fairly good description of the Potomac strata which he correlated with the Purbeck beds of England. In 1885 McGee proposed the name Potomac for these deposits. The iron ores were discussed by Benton in Volume XV of the Tenth Census Reports and localities and analysis of the ores are given. Plant remains have been found at various localities which have been described by Knowlton, Fontaine, and Ward, while Marsh has described a number of vertebrate fossils, principally dinosaurian remains, obtained near Muirkirk. The question of the age of the deposits was long a disputed one

because of the supposed contradictory evidence presented by the fossils. Marsh stoutly contended that the Potomac strata were Jurassic in age (i. e. Wealden) while the paleobotanists have as firmly held that they were Cretaceous, the whole question hinging on the Cretaceous or Jurassic age of the Wealden deposits of Europe. In 1897 Clark and Bibbins published an article in which, from stratigraphic evidence, they advanced the idea that the lower beds from which Marsh secured the dinosaurian remains probably belong to the Jurassic, while the upper members which have yielded most of the fossil plants are Cretaceous in age. In the same article the differentiation of the strata into four formations was first proposed. In a later article by the same authors on the "Geology of the Potomac Group in the Middle Atlantic Slope," an elaboration of the previous article accompanied by many maps, sections, and illustrations is given.

An important contribution to the literature of the Potomac Group is contained in a monograph of the U. S. Geological Survey entitled "Status of the Mesozoic Floras of the United States," by Ward and others. In this work many plants from the Potomac strata of Prince George's County are described and the age of the beds is discussed.

The Potomac is discussed by Clark in 1910, the Raritan formation being referred to the Upper Cretaceous. The balance of the Potomac group, on the evidence of the vertebrates which have been restudied by Lull and of the plants which have been restudied by Berry, is referred to the Lower Cretaceous.

The Upper Cretaceous.—In 1860 Tyson mentioned the presence of Cretaceous strata in Prince George's County, but gave no descriptions nor definite localities where they occur. Uhler in 1883, in a short article described the quartzitic sandstone near Collington, which he classed with the Potomac beds, but which is now considered a part of the Raritan formation. He correlated the sandstone with the Wealden of Europe.

In 1889 Clark discovered Cretaceous fossils in the bluffs at Fort Washington in strata that had previously been confused with the

Eocene beds which outcrop there. He also found similar fossils at Collington. In 1895 Clark re-visited the Fort Washington region and published his observations in a brief article in the Johns Hopkins University Circulars. He stated that the Upper Cretaceous strata found there are principally of Matawan age, but Navesink and Redbank deposits occur sparingly. In the same year he presented a paper before the Geological Society of America, in which the Upper Cretaceous deposits of the entire State were discussed. A map showing the distribution of the strata accompanied the article. White in 1891, in a correlation bulletin of the United States Geological Survey, and Clark, in 1897, in Volume I of the Maryland Geological Survey, summed up all existing knowledge concerning the Upper Cretaceous formations of the State in which references were made to Prince George's County localities. Darton in 1901, in the Washington Folio, mapped the distribution of the Matawan and Monmouth formations and briefly described the character of the deposits. Somewhat more detailed information covering a larger portion of the county is contained in the Patuxent Folio by Shattuck, Miller and Bibbins. The fossil plants, which occur principally in the Magothy formation, are described by Berry in several papers, beginning with one published in 1906.

The Eocene.—The literature relating to the Eocene strata of Prince George's County is more extensive than that pertaining to any of the other groups of formations represented within the County. This is accounted for by the presence of excellently preserved fossils in finely exposed strata at Upper Marlboro, along Piscataway Creek and in the Fort Washington bluff. With few exceptions all of the numerous articles refer either to the deposits found at these places or to the fossils obtained from them.

Pierce in 1826, was the first to mention the Eocene strata of Prince George's County. He speaks of the exposures at Upper Marlboro. In 1830 Conrad published his first paper dealing with the fossils of this region. In this publication he described several new species of fossils from Piscataway. This marked the beginning of some very careful work which he continued for over thirty years. Between 1830 and 1866 the same author published thirteen other

articles describing Eocene fossils from this County. He also made some valuable correlations as a result of his paleontological investigations.

Finch and Lea in 1833, described the Eocene exposures at Fort Washington. Ducatel studied the Eocene formations purely from an economic standpoint in his attempts to determine the value of greensand as a fertilizer. In his reports he makes frequent references to the greensand deposits of this region and gives some sections of the strata exposed at certain localities.

In 1845 and again in 1856 Bailey published descriptions of microscopic fossils found in the marls at Fort Washington. However, we cannot be positive as to the age of the strata from which they were obtained as the Eocene and Cretaceous had not then been differentiated in that region.

Tyson in his geologic reports discussed the economic value of the greensand marl deposits of the County. Heilprin, in 1881-2 and in 1884, published articles dealing almost entirely with the correlation of the Eocene deposits of the Atlantic Coastal Plain. He considered the deposits at Upper Marlboro, Piscataway, and Fort Washington, the oldest representatives of the Eocene and referred them to the Eo-Lignitic member, which forms the base of his Eocene series.

Since 1888 Clark has been the principal investigator of the Eocene deposits of Maryland and in several of his published articles he has referred to the Eocene strata of Prince George's County. He proposed the classification of the Eocene adopted in this report. The most complete article is by Clark and Martin in the Eocene volume of the Maryland Geological Survey published in 1901. In this volume the fossils of the region are fully described by specialists and each recognized species is illustrated.

The Miocene.—The Miocene strata, although extremely fossiliferous elsewhere in Maryland, are almost devoid of megascopic fossils in Prince George's County, consequently there are few references in the literature to the Miocene deposits of the region. In 1838, Conrad, who called the Miocene the Medial Tertiary, referred to these deposits as overlying the Eocene in the vicinity of Upper Marlboro and Fort Washington.

But while the Miocene strata of Prince George's County contain few shell beds they are especially rich in microscopic fossils. Diatomaceous earth from the vicinity of Piscataway and Nottingham has been studied by many investigators and many species have been described. Ehrenberg in 1844, and Bailey in 1844-5 and 1849, described microscopic organisms from Piscataway and specimens from diatomaceous earth near Nottingham have been described by Johnston, Norman, Tyson, and Woolman. Heilprin in 1884, and Dall and Harris in 1892, summed up all the information then available concerning the distribution, age, and contained fossils of the Miocene. In the Washington Folio Darton gave detailed information of the Miocene of the Washington quadrangle. The latest and most complete work on the Miocene of this section is contained in the Miocene volume of the Maryland Geological Survey published in 1904. In this volume Clark and Shattuck describe the deposits and their classification. Dall discusses their correlation, while several specialists in various groups of animals and plants describe the fossils contained in the strata.

The Pliocene (?) and Pleistocene.—The Pliocene (?) and Pleistocene deposits until comparatively recently have not been clearly differentiated hence the necessity of including them in the same section in discussing the literature.

In his report for 1834, Ducatel mentions the occurrence of gravel on the top of the Fort Washington hill, which, so far as known, is the first reference to the surficial deposits of Prince George's County.

In an article published in 1852 Desor speaks of the boulders found about Washington and says they have been carried there by the Potomac River. Their origin is traced to regions west of the Blue Ridge as is shown by the fossils which they contain. In 1877, Rogers described the gravels from the same vicinity. He states the materials to be frequently stratified and that some of the gravels bear Potsdam fossils. The origin of this material is due either to valley glaciers during the Ice Age or to swollen streams. He discusses both hypotheses without reaching any definite conclusion.

Chester in 1885, advanced the idea that the gravel areas found about Washington were continuous from Virginia to New Jersey,

and that they were transported to their present locations by glaciers during late Jurassic or early Cretaceous time.

McGee in 1886, speaks of the Pleistocene (Columbia) formation in the Washington area as "appearing to represent a subaqueous delta of the Potomac River formed when the river was far above its present level." In 1887 he described the size of the boulders in the Pleistocene deposits and stated that those brought down by the Potomac River in Quaternary time were twenty times as large as those now carried by the same stream. In other articles in 1888, 1889, 1891 and 1900 McGee further discussed these deposits and gave excellent descriptions of their features in the Washington region.

Darton, in articles published in 1891, 1893 and 1901, made valuable contributions to our knowledge of these formations. In an article published in 1901 Shattuck described the gravel deposits of the North Atlantic Coastal Plain, reviewed former ideas and classifications of these late formations, and proposed the classification adopted in this report. The latest and most complete discussion is contained in a recent volume issued by the Maryland Geological Survey in 1906 on the Pliocene and Pleistocene Formations of Maryland. It contains a full discussion of the deposits and also the fauna and flora which they contain.

BIBLIOGRAPHY.

1624.

SMITH, JOHN. A Generall Historie of Virginia, New England, and the Sumner Isles, etc. London, 1624. [Several editions.]

This work contains many interesting notes on the physiography of Chesapeake Bay and its tributaries, and briefly describes the clays and gravels along their shores. The "Powtomeke" (Potomac) river is said to be navigable 140 miles from its mouth. For a reproduction and discussion of Smith's map see Md. Geol. Surv., vol. ii, pp. 347-360.

1809.

GODON, SILVAIN. Observations to serve for the mineralogical Map of the State of Maryland. (Read Nov. 6, 1809.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 319-323.

The author states that Washington is built on alluvial land and that Rock Creek forms the boundary between the "primitive" and the "alluvial" strata.

LATROBE, B. H. An account of the Freestone Quarries on the Potomac and Rappahannock rivers. (Read Feb. 10, 1807.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 283-293.

The course of the Potomac river below Washington is described.

1817.

MACLURE, WM. Observations on the Geology of the United States of America, with some remarks on the effect produced on the nature and fertility of soils by the decomposition of the different classes of rocks. 12mo, 2 plates, Phila., 1817. Is an elaboration of an article published in 1809 in Trans. Amer. Phil. Soc., o. s. vol. vi, pp. 411-428. Republished in Trans. Amer. Phil. Soc., n. s. vol. i, 1818, pp. 1-91.

This work is classic, as it was the first attempt to treat the geology of the entire country and contains the first published geological map of the United States. The whole Coastal Plain constitutes the "alluvial" formation and the Piedmont Plateau the "primitive."

1818.

MITCHELL, SAMUEL L. Essay on the Theory of the Earth by M. Cuvier to which are now added Observations on the Geology of North America by Samuel L. Mitchell. 8vo, 431 pp., 8 plates. New York, 1818.

Describes the indurated shell rock at Upper Marlboro. Also describes the topography in and about Washington. Mentions the finding of lignitized branches and trunks of trees containing pyrite in abundance 54 feet beneath the surface of Capitol Hill, and a "bough of sound and seasoned black walnut" 45 feet below the surface near the Eastern branch. Bones and sharks' teeth are reported from further down the river. "Digging has shown that all the strata are horizontal; and the pebbles and stones mingled with the sand are rounded as if worn by water," p. 396.

1820.

HAYDEN, HORACE H. Geological Essays; or An Inquiry into some of the Geological Phenomena to be found in various parts of America, and elsewhere. 8vo, 412 pp. Baltimore, 1820.

The writer contends that the unconsolidated deposits bordering the Atlantic Ocean are not alluvial materials, but have been brought to their present position by an ocean current which swept over the eastern part of the country in a southwesterly direction. The rise of the ocean is believed to have been caused by an increase of water due to the melting of the polar ice produced by a shifting of the earth's axis.

1824.

FINCH, JOHN. Geological Essay on the Tertiary Formations in America. (Read before Acad. Nat. Sci., Phila., July 15, 1823.)

Amer. Jour. Sci., vol. vii, pp. 31-43.

Objection is made to the term "alluvial formation" of Maclure and others on the ground that the deposits are for the most part not of alluvial origin, and also that, as used, it includes a number of distinct formations that can be correlated with the "newer secondary and tertiary formations of France, England, Spain, Germany, Italy, Hungary, Poland, Iceland, Egypt, and Hindoostan." The writer makes some provisional correlations which are now known to be wrong. He admits, however, that the data are insufficient for accurate correlation. The clay which is found beneath the 54 feet of "diluvial gravel" on Capitol Hill, Washington, and which contains remains of trees is considered by him the equivalent of the London clay.

1826.

PIERCE, JAMES. Practical remarks on the shell marl region of the eastern parts of Virginia and Maryland, and upon the bituminous coal formation in Virginia and the contiguous region; extracted from a letter to the Editor Amer. Jour. Sci., vol. xi, pp. 54-59, 1826.

Mentions the occurrence of shell marl of marine origin in the "alluvial" district of Maryland on both sides of Chesapeake Bay, and discusses its value as a fertilizer in the renovation of exhausted soils. Refers specifically to the calcareous-cemented beds of shells at "Marlborough" (Upper Marlboro) and other places west of Chesapeake Bay. He states that the shell marl extends up the Potomac river to within 8 miles of Washington.

1830.

CONRAD, T. A. On the Geology and Organic Remains of a part of the Peninsula of Maryland.

Jour. Acad. Nat. Sci., Phila., vol. vi, pt. 2, 1830, pp. 205-230, 2 plates.

Deposits of Tertiary age about Piscataway and Fort Washington are described and correlated with the London clay, upper marine. Several new forms of fossils are described. On the basis of the fossils the Tertiary deposits of these two localities are declared to be older than the Tertiary of Calvert and St. Mary's counties.

MORTON, SAMUEL G. Synopsis of the Organic Remains of the Ferrugin on Sand Formation of the United States; with geological remarks.

Amer. Jour. Sci., vol. xvii, pp. 274-295; vol. xviii, pp. 243-250, 1830.

The writer describes fossils from the green-sand marls of New Jersey, from the Deep Cut of the Chesapeake and Delaware Canal, and from Maryland. The author contends that the green sands are pre-Tertiary in age and should be correlated with the Lower Chalk of England. Eaton had claimed that these beds were of Tertiary age.

1832.

CONRAD, T. A. Fossil shells of the Tertiary Formations of North America illustrated by figures drawn on Stone from Nature. Vol. i, pts. 1 and 2, 28 pp. Phila., 1832.

Republished by G. D. Harris, Washington, 1893.

Cardita planicosta is reported from Middle Tertiary near Piscataway. The stratum containing the fossil is supposed to be the equivalent of the London clay and calcaire grossier. A gigantic *Cucullaea* and *Ostrea compressirostia* are reported in similar material at Fort Washington.

1833.

FINCH, J. Travels in the United States of America and Canada. 8vo, 455 pp. London, 1833.

The author speaks of the red sandstones at Bladenshurg used for foundations and of the red soil exposed in ravines in the city of Washington. He describes the greensand marl at Fort Washington together with its contained fossils.—*Pecten, Cardium, Arca, Ostrea, Ichthyosaurus, Crodiles,* and *Sharks.* He says that the marl is used as manure.

LEA, ISAAC. Contributions to Geology. 8vo, 237 pp., 6 plates. Phila., 1833.

The Tertiary deposits of Claiborne, Alabama, are fully described and are correlated with the Fort Washington beds.

1834.

CONRAD, T. A. Observations on the Tertiary and more recent formations of a portion of the Southern States.

Jour. Acad. Nat. Sci., Phila., vol. vii, 1834, pp. 116-129.

The author uses the term "Eocene" in describing the deposits at Fort Washington. He states that the Eocene strata extend to the southwest from Maryland, but considers the deposits of Maryland as younger than those of Claiborne, Ala., and probably to be correlated with the miocene of Europe.

DUCATEL, J. T., and ALEXANDER, J. H. Report on the Projected Survey of the State of Maryland, pursuant to a resolution of the General Assembly. 8vo, 39 pp. Annapolis, 1834. Map. Several editions.

Amer. Jour. Sci., vol. xxvii, 1835, pp. 1-39.

Shell marl deposits are reported to occur at Indian Point, on the western branch of the Patuxent River, at "Upper Marlborough," and at Fort Washington. The deposits at the latter place are said to have no practical value. Copperas ore (iron pyrites) is said to occur at Oxen Creek and bog iron ore in the neighborhood of Queen Anne (Hardesty); while carbonate of iron ore is described from "Snowden's mine bank, situated on the east side of the Washington Turnpike, near the twenty-first mile stone and about half a mile from the road. "The ore was formerly extracted from this bank in large quantities, as is evident from the excavation."

HARLAN, RICHARD. Critical Notices of Various Organic Remains Hitherto Discovered in North America. (Read May 21, 1834.)

Trans. Geol. Soc. Pa., vol. I, pt. L 1834, pp. 46-112.

The author states that specimens of *Egnus callabus* were "found in excavating for the Chesapeake and Ohio Canal near Georgetown, D. C., not far from the Potomac River." (p. 61.)

MORTON, S. G. Synopsis of the Organic Remains of the Cretaceous Group of the United States. To which is added an appendix containing a tabular view of the tertiary fossils hitherto discovered in North America. 8vo, 88 pp. Phila., 1834.

(Abst.) Amer. Jour. Sci., vol. xxvii, 1835, pp. 377-381.

He states that the "Ferruginous Sand" is present at Fort Washington, where it contains *exogyra*.

1835.

CONRAD, T. A. Observations on the Eocene Deposits of the United States. Fossil Shells of the Tertiary Formations of North America, vol. i, No. 3, pp. 29-36. Phila., 1835.

Republish by G. D. Harris, Washington, 1893.

Describes the distribution of the Eocene of the county mentioning its occurrence at Fort Washington, Piscataway and Upper Marlborough. The latter place the author believed was the northern limit of the Eocene.

CONRAD, T. A. Observations on the Tertiary Strata of the Atlantic Coast.

Amer. Jour. Sci., vol. xxviii, pp. 104-111, 280-282.

He considers the miocene absent in this region, the Older Phiocene resting directly on the Eocene. The beds containing *Perna maxillata* are referred to the Older Phiocene, and the St. Mary's river beds to the Medial Phiocene.

CONRAD, T. A. Observations on a portion of the Atlantic Tertiary Region.

Trans. Geol. Soc. Penn., vol. I, 1835, pp. 335-341, pl. 13.

Deposits at Piscataway and Upper Marlborough are described. At the former locality the following new forms are described: *Panopea elongata*, *modiola cretacea*, and *Turritella humerosa*.

DUCATEL, J. T. and ALEXANDER, J. H. Report on the New Map of Maryland, 1834. Annapolis, 1835(?). 8vo, 59+1 pp. Two maps and one folded table. Contains Engineer's and Geologist's reports, which were also issued separately.

Md. House of Delegates, Dec. Sess., 1834.

In the report of the engineer, Mr. Alexander, a very good account is given of the way in which Piscataway Creek is being filled up with silt. It is recommended that canals be dug along both sides of the stream to receive the wash from the hills and empty it into the Potomac rather than permitting it to fill up Piscataway Creek, an expedient perhaps, however, more costly than useful.

In the geologist's report the Eocene deposits at Fort Washington, Piscataway, and Upper Marlborough are described while the value of the shell marls of the region for economic purposes is discussed. He says that no Miocene has yet been recognized in the State. The physiography of the region is described and mention is made of the gravel cap at Fort Washington, though it is not separated from the Eocene. The map contains many notes in regard to the geology of the region bordering the Potomac River.

MARTIN, JOSEPH. A Comprehensive Description of Virginia, and the District of Columbia. Richmond, 1835(?).

He describes the separation of the "Primitive" and "Alluvial" formations in the District. In the former gneiss abounds and is succeeded by "amphibolic" rock.

MORTON, S. G. Additional Observations (to Synopsis). 8vo, 4 pp. Phila., June, 1835.

Gryphaea vomer is added to the Eocene forms obtained at Upper Marlborough and Piscataway.

1836.

DUCATEL, J. T. and ALEXANDER, J. H. Report on the New Map of Maryland, 1835. 8vo, 84 pp. Maps. Annapolis, 1836.

Md. Pub. Doc., Dec. Sess., 1835.

Engineer's Report, pp. 1-34, Geologist's Report, pp. 35-84.

Both reports also published separately.

In the engineer's report a good description of Piscataway Creek is given and the changes which are taking place in it. A plan for a canal extending up the creek to the town of Piscataway is discussed.

Ducatel reports the presence of a micaceous black sand in the deep ravines bordering the Mattaponi in the vicinity of Nottingham. It is said to form a part of the "ferruginous sand formation" which he believes to belong to the Secondary Analyses of micaceous black sand, green sand period (1-83) and shell marl (p. 82) are given.

FEATHERSTONHAUGH, G. W. Report of a Geological Reconnaissance made in 1835 from the seat of government by way of Green Bay and the Wisconsin Territory on the Coteau du Prairie, an elevated ridge dividing the Missouri from the St. Peters river.

169 pp., 4 pls., Washington, 1836.

Describes the decomposed gneiss above Georgetown and along Rock Creek. He says that the gneiss underlies Washington and Georgetown dipping to the southeast.

1837.

DUCATEL, J. T. and ALEXANDER, J. H. Report on the New Map of Maryland, 1836. 8vo, 104 pp., 5 maps. Annapolis, 1837.

Md. House of Delegates, Dec. Sess., 1836.

Geologist's Report, pp. 1-60, Engineer's Report, pp. 61-104.

Ducatel describes shell and greensand deposits of Eocene and Miocene age from many places in the county and discusses their economic value as fertilizers. He mentions the pink clay (Marlboro) occurring with greensand north of Upper Marlborough.

DUCATEL, J. T. Outline of the Physical Geography of Maryland, embracing its prominent Geological Features.

Trans. Md. Acad. Sci. and Lit., Vol. I, Pt. I, 1837, pp. 24-54, with map.

A general description of the physiography and geology of the entire State is given with many details of local features. It is a general summary of information previously published in various places. Mention is made of the covering of boulders and coarse gravel near the inner edge of the Secondary (Cretaceous) rocks while farther out the sands and clays of the Secondary and Tertiary formations are uncovered.

1838.

CONRAD, T. A. Fossils of the Medial Tertiary of the United States. No. 1, 1838. [Description on cover 1839 & '40.] 32 pp. Plates I-XVII.

Republished by William H. Dall, Washington, 1893.

A general description of the distribution and characteristics of the Miocene of the Atlantic Coastal Plain is given. The Miocene is called the Medial Tertiary or Older Pliocene and the Eocene is called Lower Tertiary. The Medial Tertiary is said to overlie the Lower Tertiary at Upper Marlboro and is found to the south of a line drawn from Annapolis to Fort Washington.

1839.

CONRAD, T. A. Notes on American Geology. Observations on Characteristic Fossils, and upon a fall of Temperature in different Geological Epochs.

Amer. Jour. Sci., vol. xxxv, 1839, pp. 237-251.

"At Upper Marlborough and Piscataway, in Maryland, a deposit of the Eocene period occurs, composed of the detritus of green sand, a material originating in the cretaceous epoch. One fossil of the latter formation, (*Gryphaea vomer*, [*ostrea lateralis, Wilson*]) is not uncommon among the Eocene fossils. This is at the same time the lightest and most indestructible of the cretaceous shells, and therefore the one most likely to be carried unbroken with the detritus of the green sand."

1842.

CONRAD, T. A. Descriptions of New Tertiary Fossils.

Second Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 192-194, 2 pls.

Pholadomya marylandica is described from Piscataway.

CONRAD, T. A. Observations on a portion of the Atlantic Tertiary Region, with a description of new species of organic remains.

Second Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 171-192.

The deposits of the Eocene at Piscataway, Upper Marlboro, and Fort Washington are described and their characteristic fossils mentioned. They are correlated with the Bognor rocks of Great Britain and the Claiborne beds of Alabama.

The Miocene and Eocene are said to not be connected by a single fossil common to both periods while three fornia found in the Upper Secondary are found in the Eocene.

1843.

DUCATEL, JULIUS T. Physical History of Maryland.

Abstract Proc. Amer. Phil. Soc., vol. iii, 1843, pp. 157-158.

"The Eastern Shore is shown to consist of something more than arid sand-hills and pestilential marshes; and the Western Shore not to depend exclusively upon the rich valleys of Frederick and Hagerstown for its supplies."

1844.

B(AILEY), J. W. Account of some New Infusorial Forms discovered in the Fossil Infusoria from Petersburg, Va., and Piscataway, Md.

Amer. Jour. Sci., vol. xlvi, 1844, pp. 137-141, pl. iii.

Ten species are described and over 30 figures given.

EHRENBERG, C. G. Ueber zwei neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord Amerika und eine Vergleichung derselben mit dem organischen Kreide-Gebilden in Europa und Afrika.

Bericht. k. p. akad. Wiss. Berlin, 1844, pp. 57-97.

Reviewed Amer. Jour. Sci., vol. xlviii, 1845, pp. 201-204.

Sixty-eight species of infusoria are enumerated from Piscataway including a great many new forms. Comparisons are made with the diatoms occurring at Richmond and Petersburg, Virginia, and in Europe and Africa.

ROGERS, H. D. Address delivered at the Meeting of the Association of American Geologists and Naturalists.

Amer. Jour. Sci., vol. xlvii, 1844, pp. 137-160, 247-278.

The article consists of a resumé of the geological work done up to that time in the entire United States. Reference is made to Conrad's work on the Eocene fossils found at Upper Marlborough and Bailey's investigations on the infusoria near Piscataway.

ROGERS, WM. B. [Tertiary Infusorial Formation of Maryland.]

Amer. Jour. Sci., 2nd ser., vol. xlvi, 1844, pp. 141-142.

A short description of the geographical extent of the infusorial stratum is given. He places the deposits near the base of the "Meiocene." Names of infusoria identified by Professor Bailey are given.

1845.

BAILEY, J. W. Notice of some New Localities of Infusoria, Fossil and Recent.

Amer. Jour. Sci., vol. xlviii, 1845, pp. 321-343, pl. iv.

Gives lists of forms found in Eocene marl of Fort Washington and in Miocene deposits near Piscataway. Casts of *Polythalamia* are reported from Fort Washington.

1846.

CONRAD, T. A. Observations on the Eocene Formation of the United States, with descriptions of species of shells, etc., occurring in it.

Amer. Jour. Sci., 2nd ser., vol. i, 1846, pp. 209-221, 395-405, pls. i, ii, iii, iv.

Following fossils are described from Piscataway: *Pholas petrosa*, *Pholadomya Marylandica*, *Panopaea intermedia*, *Crassatella alaeformis*, and *Crassatella palmula* from Upper Marlborough.

1847.

CONRAD, T. A. Observations on the Eocene Formation and description of one hundred and five new fossils of that period from the vicinity of Vicksburg, Mississippi. With appendix.

Proc. Acad. Nat. Sci. Phila., vol. iii, 1847, pp. 280-299.

The writer regards the Eocene deposits of Prince George's County as Lower Eocene and the Claiborne, Charleston, and Vicksburg beds as Upper Eocene.

1848.

CONRAD, T. A. Observations on the Eocene Formation and descriptions of one hundred and five new fossils of that period from the vicinity of Vicksburg, Mississippi, with an appendix. [Description of New Eocene Fossils in the cabinet of Lardner Vanuxem.]

Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, 1849, pp. 111-134, pls. 11-14.

The Fort Washington, Piscataway, and Upper Marlborough Eocene deposits referred to the Lower Eocene are correlated with the Alabama deposits at Claiborne and St. Stephens because of the presence of *Ostrea sellaeformis*. Mention is made of several Eocene species from this county.

1849.

BAILEY, J. W. New Localities of Infusoria in the Tertiary of Maryland.

Amer. Jour. Sci., 2nd ser., vol. vii, 1849, p. 437.

Piscataway is mentioned as the most northerly point where infusoria have been found in the Miocene.

1852.

DESOR, E. Post Pliocene of the Southern States and its relation to the Laurentian of the North and the Deposits of the Valley of the Mississippi.

Amer. Jour. Sci., 2nd ser., vol. xiv, 1852, pp. 49-59.

The boulders in the vicinity of Washington are said to have been brought to their present position by floating ice bergs carried by the Potomac river from beyond the Blue Ridge. A suggested correlation of the superficial deposits of Maryland with the Laurentian of Canada and the post-Pliocene of South Carolina is discussed.

FISHER, R. S. Gazetteer of the State of Maryland compiled from the returns of the Seventh Census of the United States. New York and Baltimore, 1852, 8vo, 122 pp.

Contains numerous descriptions of the geography and geology of different portions of the State. The diatomaceous earth (called "siliceous clay") bed at Piscataway is briefly described.

HIGGINS, JAMES. The Second Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates of Maryland. 8vo, 118 pp. Annapolis, 1852.

Md. House of Delegates, Jan. Sess., 1852. 8vo, 126 pp.

Large deposits of phosphate of iron are reported to occur on the farm of Mr. James Mulliken and it has also been noticed in several other places in that neighborhood. "When pure it contains about 28 per cent. of phosphoric acid. The average of six analyses of the above deposit, taken and made at different times, shows 16 per cent. of phosphoric acid."

The soils and marls of the county are discussed and many analyses given.

JOHNSON, ALEXANDER S. Notice of some undescribed Infusorial Shells.

Amer. Jour. Sci., 2nd ser., vol. xiii, 1852, p. 33.

The infusoria *Asterodiscus nonarius* and *Asterolampra septenaria* from Piscataway are described.

1853.

MARCOU, JULES. A Geologieal Map of the United States and the British Provinees of North America, with an explanatory text. (etc.) 8vo. Boston, 1853.

Shows the general distribution of the Coastal Plain strata. No Cretaceous represented on the Western Shore of Chesapeake Bay.

1855.

MARCOU, J. Resumé explieatif d'un earte géologique des États-Unis et des provinees anglaises de l'Amérique.

Bull. Soc. Geol. France, 2nd ser., tome xii, 1855, pp. 813-936. Colored geological map.

Mention is made of the occurrence of Eocene at Fort Washington and brief statements concerning the Cretaceous and Tertiary deposits of the entire State.

1856.

BAILEY, J. W. On the Origin of Greensand, and its formation in the oceans of the present epoeh.

Amer. Jour. Sci., 2nd ser., vol. xxii, 1856, pp. 280-284.

Proc. Bost. Soc. Nat. Hist., vol. v, pp. 364-368.

Reference is made to the abundant casts of *Polythalamia* in the Eocene greensand of Fort Washington.

EHRENBERG, C. G. Zur Mikrogeologie.

Two vols. and atlas, royal folio, 41 pls. Leipzig, 1854-56.

Mention forms of protozoa from Fort Washington.

1859.

JOHNSTON, CHRISTOPHER. Notes on Odontology.

Amer. Jour. Dental Sci., Phila., n. s. vol. ix, No. 3, 1859, pp. 337-343.

A description is given of *Astrodon* (afterwards called *Astrodon johnstoni*) from Bladensburg.

1860.

TYSON, PHILIP T. First Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, January,

1860. 8vo, 145 pp. Maps. Appendix. Mineral Resources of Maryland, 20 pp. Annapolis, 1860.

The report is accompanied by a colored geological map which shows the distribution of the various formations. The Coastal Plain formations represented are the Cretaceous, Tertiary, and Post Tertiary, while the iron-ore clays of the Cretaceous are separated from the other Cretaceous deposits. A brief description is given of each formation.

The green sand and sbell marl deposits are mentioned. The Cretaceous clays of the county are briefly described. The carbonate of iron ores of the Cretaceous are described and also deposits of iron pyrites near Oxon Creek.

1861.

JOHNSTON, CHRISTOPHER. Upon a Diatomaceous Earth from Nottingham, Calvert Co., Maryland.

Proc. Amer. Assoc. Adv. Sci., vol. xiv, 1860, pp. 159-161.

The writer gives reasons for believing that the "Bermuda earth" must have come from Nottingham. A brief description of the deposit is given. Tyson is quoted as being unable to decide whether the bed belongs to the Upper Eocene or the Lower Miocene.

NORMAN, GEORGE. On some Undescribed Species of Diatomaceae. (Read Nov. 14, 1860.)

Trans. Micros. Soc., London, n. s. vol. ix, 1861, pp. 5-9.

Describes and figures *Aulacodiscus sollitianus* (n. sp.) from Nottingham, Md.

1862.

TYSON, PHILIP T. Second Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, January, 1862. 8vo, 92 pp. Annapolis, 1862.

Among the mineral resources described are the following from this county: Carbonate of iron ores supposed to belong to the oölitic period, a large deposit of iron pyrites at Oxen Creek, five miles south of Washington, clays, and tripoli near Nottingham.

1864.

CONRAD, T. A. Notes on Shells, with description of new fossil Genera and Species.

Proc. Acad. Nat. Sci., Phila., vol. xvi, 1864, pp. 211-214.

Dosiniopsis meekii is reported from a locality six miles east of Washington where it is said to occur "abundantly in a dark grey quartzose sand." It is said to characterize the oldest portion of the American Eocene which has yet been observed. p. 213.

1865.

CONRAD, T. A. Observations on the Eocene Lignite Formation of the United States.

Proc. Acad. Nat. Sci., Phila. vol. xvii, 1865, pp. 70-73.

(Abst). Amer. Jour. Sci., 2d ser., vol. xi, 1865, pp. 265-268.

The lignitic beds now included in the Magothy formation are considered to constitute the basal beds of the Eocene, and are correlated with the London clay of Europe. "They reveal a singular state of the globe at the commencement of the Tertiary period, presenting a vast level region covered by a dense forest, in which palms and oaks grew side by side, interspersed with lakes and rivers, and long shallow bays of salt water penetrating to the interior of the continents. This state of the globe was exhibited in Europe and America at the same time." p. 268.

CONRAD, T. A. Catalogue of the Eocene and Oligocene Testacea of the United States.

Amer. Jour. Conch., vol. i, 1865, pp. 1-35.

Several species of Eocene fossils from Upper Marlboro and Piscataway Creek are included in the lists.

LEIDY, JOSEPH. Cretaceous Reptiles of the United States.

Smith. Contrib. to Knowledge, No. 192, vol. xiv, 1865, 135 pp., 20 pls.

Teeth of *Astrodon johnstoni* found in an iron ore bed near Bladensburg, are described and figured.

1866.

CONRAD, T. A. Check List of the Invertebrate Fossils of North America (Eocene and Oligocene).

Smith. Misc. Coll., vol. vii, 1866, 41 pp.

Lists of all Eocene and Ohjocene fossils known at that time are given but without exact locality references. The Eocene deposits near Washington, at Piscataway, and at Upper Marlboro are referred to the Lower Eocene.

1867.

HIGGINS, JAMES. A Succinct Exposition of the Industrial Resources and Agricultural Advantages of the State of Maryland, 8vo, 109+iii pp.

Md. House of Delegates, Jan. Sess., 1867. [DD.]

Md. Sen. Doc., Jan. Sess., 1867. [U.]

Contains a description of the soiis and physiographic features of each of the counties of the State.

1868.

COPE, E. D. (On the discovery of the fresh-water origin of certain deposits of sand and clays in west New Jersey.)

Proc. Acad. Nat. Sci., Phila., vol. xx, 1868, pp. 157-158.

A brief concise description of the distribution and character of the deposits, now designated the Potomac Group, is given and Tyson is quoted as believing that they are of Jurassic rather than Cretaceous. "The whole formation indicates the existence of an extended body of fresh water, having a direction and outline similar to that in which were deposited the red sandstones and shales of the Triassic belt, which extends parallel to its northwest margin throughout the States in which it occurs." (p. 157.)

1875.

JOHNSTON, CHRISTOPHER. About the Rediscovery of the "Bermuda Tripoli" near Nottingham, on the Patuxent, Prince George's County, Md.

Proc. Boston Soc. Nat. Hist., vol. xvii, 1875, pp. 127-129.

The writer describes the circumstances connected with the discovery that the so-called "Bermuda tripoli" never came from Bermuda, but from the vicinity of Nottingham, Prince George's county.

SULLIVANT, J. [Letter to Professor Christopher Johnston on Bermuda Tripoli in Maryland.]

Proc. Boston Soc. Nat. Hist., vol. xvii, 1875, pp. 422-423.

The writer expresses his belief that the so-called "Bermuda Tripoli" did not come from Bermuda or Bermuda Hundreds, Virginia, but from Nottingham, Md.

1879.

FONTAINE, W. M. Notes on the Mesozoic of Virginia.

Amer. Jour. Sci., 3d ser., vol. xvii, 1879, pp. 25-39, 151-157, 229-239.

Brief descriptions are given of the iron ore clays of the Potomac group in the belt extending from Washington to Baltimore. He speaks of the Potsdam and Azoic boulders about Washington and between there and Baltimore which he thinks were brought down during the Jurassic by icebergs and glaciers.

1880.

HEILPRIN, ANGELO. On the Stratigraphical Evidence Afforded by the Tertiary Fossils of the Peninsula of Maryland.

Proc. Acad. Nat. Sci., Phila., vol. xxxii, 1880, pp. 20-33.

After a careful examination of the fossils found along the Patuxent, Choptank and St. Mary's rivers and the Calvert Cliffs, the author proposes the separation of the Miocene into the Older and Newer periods. The beds at Fair Haven are typical Older Miocene and the St. Mary's lower Patuxent, and Choptank river beds belong to the Newer Miocene.

1881.

HEILPIN, ANGELO. Note on the Approximate Position of the Eocene Deposits of Maryland.

Proc. Acad. Nat. Sci., Phila., vol. xxxiii, 1881, pp. 444-447.

The Eocene of Maryland, consisting of "the Piscataway sands below, and the Marlborough rock above" is supposed to represent "a horizon nearly equal to that of the Thanet sands of England and the Bracheux sands of the Paris basin, or of the British Bognor rock (= London Clay)" are also correlated with the Alabama deposits. They are supposed to be equivalent to the beds "near the base of the 'Buhrstone' or possibly even lower." (p. 447.)

1882.

HEILPRIN, ANGELO. On the relative ages and classification of the Post-Eocene Tertiary Deposits of the Atlantic Slope.

Proc. Acad. Nat. Sci., Phila., vol. xxxiv, 1882, pp. 150-186.

(Abst.) Amer. Jour. Sci., 3d ser., vol. xxiv, 1882, pp. 228-229.

Amer. Nat., vol. xvii, 1883, p. 308.

From a comparison of faunas the Eocene deposits of Maryland are correlated with the Eo-Ligniter of Alabama, and the Miocene beds of the State are grouped in a division called the Marylandian which is supposed to be older than any other Miocene beds of this country, with the possible exception of the basal Miocene beds of Virginia which may be contemporaneous.

1883.

SMOCK, J. C. The Useful Minerals of the United States. Min. Resources of the U. S., 1882. Washington, 1883, pp. 690-693.

The following minerals are reported from this county: Limonite from Snowden's Bank, Greensand and shell marls, Lignite in clay, Pyrite from Oxen Creek, Siderite, Tripolite from near Nottingham.

UHLER, P. R. Geology of the Surface Features of the Baltimore Area. Johns Hopkins Univ. Circ. No. 21, vol. ii, 1883, pp. 52-53. (Abst) Science, vol. i, 1883, pp. 75-76, 277.

The hard resistant sandstones that outcrop near Collington (Collingwood as given in the article) are referred to the Wealden and are said to represent the remnants of a widespread deposit. The conditions that prevailed during the Jurassic, Cretaceous, and Pleistocene periods are briefly described.

WILBUR, F. A. Marls. Mineral Resources U. S., 1882, Washington, 1883, p. 522.

Greensand marls of Cretaceous age are said to occur in Kent, Cecil and Prince George's counties.

1884.

HEILPRIN, ANGELO. The Tertiary Geology of the Eastern and Southern United States.

Jour. Phila. Acad. Nat. Sci., vol. ix, pt. i, pp. 115-154, map, 1884.

The distribution of the Tertiary strata of the State is given approximately. The Eocene is correlated with the base of the Buhrstone or the Eo-lignitic of Alabama and with the London Clay. The Miocene of the State is divided into two formations, the older or Marylandian which is regarded as possibly Oligocene in age, and the newer or Virginian. The former is exposed in Anne Arundel, Calvert, and Charles counties and the latter at Easton, on the Choptank River, and in St. Mary's County.

HEILPRIN, ANGELO. Contributions to the Tertiary Geology and Paleontology of the United States. 4to 117 pp., 1 map. Phila., 1884.

Contains a number of articles all but one of which were previously published in the Proceedings or Journal of the Phila. Academy of Natural Sciences. Some of these articles are listed on preceding pages.

MERRILL, GEO. P. Preliminary note on the Crystalline Schists of the District of Columbia.

Proc. U. S. Nat. Mus., vol. vi, 1884, pp. 159-161.
(Abst.) Science., vol. ii, 1883, pp. 829-830.
A brief description of some of the crystullus rocks near Washington.

MERRILL, GEO. P. (Notes on the Building Stones of Washington, D. C.) Tenth Census, vol. x. Washington, 1884. p. 357-361.

Some brief statements descriptive of the local building stones are made though the greater portion of the article consists of a discussion of the building stones used in the building operations of Washington, most of which are brought from a distance.

1885.

CHESTER, FREDERICK D. The Gravels of the Southern Delaware Peninsula.

Amer. Jour. Sci., 3d ser., vol. xxix, 1885, pp. 36-44.

The high level gravels about Washington are said to be contemporaneous with the high level or Bryn Mawr gravels of Delaware and southeastern Pennsylvania which are questionably referred to the Cretaceous.

MCGEE, W J. The Geology of the District. The Evening Star, Washington July 11, 1885.

In the article the author states that "but three essentially distinct formations occur within the District of Columbia. These are: (1) the Washington gneiss, which includes the gneisses, mica schists, amphibolites (massive green stones) and related crystalline rocks so well exposed along the Potomac above Georgetown; (2) the Potomac formation, comprising the laminated clays, sands and gravels spread over the highest lands of the District, and (3) the Columbia formation, made up of the brick clays, sands and gravels prevalling throughout the bluff-bound amphitheatre in which Washington is located." The Potomac formation is said to be of Lower Cretaceous age and to have been deposited in shallow water near the shore when the ocean stood 600 feet above its present level. The Columbia formation is said to be "apparently a delta deposit laid down in the broad estuary of the Potomac that existed when the waters of the ocean rose more than 100 feet above present tide level." The various terraces about Washington are also described.

ROBINSON, T. The Strata Exposed in the East Shaft of the Water Works Extension.

Abst. Bull. Phil. Soc., Washington, vol. vii, 1885, pp. 69-71.

The section shows a thickness of about 144 feet of Columbia and Potomac deposits representing 23 different strata. The Piedmont crystallines were penetrated to the depth of 43 feet.

SPENCER, J. W. Occurrence of Boulders of Decomposition at Washington, D. C., and elsewhere.

Amer. Nat., vol. xix, 1885, pp. 163-165.

Briefly describes decomposition boulders of gneiss along the Potomac River near Georgetown.

1886.

BENTON, EDWARD R. Notes on the samples of iron ore collected in Maryland.

Tenth Census. vol. xv, Mining Industries of the U. S. Washington, 1886, pp. 245-260.

Several sections of the strata exposed in iron mines near Beitsville, Branchville, and Muirkirk are given, together with analyses of the ores.

McGEE, W J. Geological Formations Underlying Washington and Vicinity. Rep't Health Officer of the District of Columbia for the year ending June 30, 1885, pp. 19-21, 23-25.

Abst. Amer. Jour. Sci., 3d ser., vol. xxxi, 1886, pp. 473-4.

Speaks of the Columbia formation about Washington appearing "to represent a subaqueous delta of the Potomac river, formed when the sea rose far above its present level and fashioned the marine terraces exhibited in the bluffs. Its absence above sea level east of the Eastern Branch may be attributed to a dislocation trending parallel to the Appalachians and the Atlantic coast." The Potomac formation is also briefly described.

PEALE, A. C. Lists and Analyses of the Mineral Springs of the United States.

Bull. U. S. Geol. Survey, No. 32, 1886, pp. 51-53.

The saline and chalybeate Spa Springs at Bladensburg are included in the list of Maryland springs.

PUMPELLY, R. Geological and Geographical Distribution of the Iron Ores of the United States.

Tenth Census, vol. xv, Mining Industries of the U. S. Washington, 1886, pp. 3-36.

Brief reference is made (p. 16) to the Potomac iron ores between Baltimore and Washington.

1887.

McGEE, W J. Ovibos cavifrons from the Loess of Iowa.

Amer. Jour. Sci., 3d ser., vol. xxxiv, 1887, pp. 217-220.

"During the earlier epoch of Quaternary cold, the middle Atlantic slope was submerged to a depth of over three hundred feet, and its rivers built deltas at their embouchures into the expanded Atlantic along the inland margin of the Coastal Plain of today." The ice-borne boulders brought down by the Susquehanna at that time are said to have been fifty times as large as those carried at the present time and those brought by the Patapsco and Potomac twenty times the size of those of today.

WHITE, I. C. Rounded Boulders at High Altitudes along some Appalachian Rivers.

Amer. Jour. Sci., 3d ser., vol. xxxiv, 1887, pp. 374-381.

"Submergence, with re-elevation in comparatively recent times, will then give a sufficient explanation for the existence of the elevated bowlder deposits in the vicinity of Washington, D. C., Richmond, Philadelphia, and possibly as far west as Cumberland."

1888.

CLARK, WM. B. On three Geological Excursions made during the months of October and November, 1887, into the southern counties of Maryland.

Johns Hopkins Univ. Circ., No. 63, vol. vii, 1888, pp. 65-67.

The following fossils are reported from the Eocene at Fort Washington: *Cucullaea gigantea*, Conrad; *Crassatella*, sp.; *Cytherea*, sp.; *Cytherea* (Dosiniopsis) Meekii, Conrad; *Turritella Mortoni*, Conrad; Sharks teeth at Upper Marlboro a green and yellow variegated marl containing casts or fragments of several genera of mollusca is said to be well exposed.

KNOWLTON, F. H. The Fossil Lignites of the Potomac Formation.

Proc. Amer. Assoc. Adv. Sci., vol. xxxvii, 1888, pp. 206-208.

The characteristics and mode of occurrence of the lignitized and silicified plant remains of the Potomac formation are briefly described.

MARSH, O. C. Notice of a New Genus of Sauropoda and other new Dinosaurs from the Potomac Formation.

Amer. Jour. Sci., 3d ser., vol. xxxv, 1888, pp. 89-94, figs. 1-9.

The remains of three new species of herbivorous and two new species of carnivorous dinosaurs obtained from the Potomac strata of Prince George's county are described and figured. The author states that the fossils are "apparently of Upper Jurassic age, but quite distinct from any hitherto discovered in this country."

MCGEE, W J. The Geology of the Head of Chesapeake Bay.

7th An. Report U. S. Geol. Surv. Washington, 1888, pp. 537-646.

Abst. Amer. Geol., vol. i, 1887, pp. 113-115.

Contains a general discussion of the Potomac and Columbia deposits. Evidence is given to prove recent displacements in the vicinity of the "fall line." At Washington the total displacement is from 75 to 100 feet.

McGEE, W J. Three Formations of the Middle Atlantic Slope.

Amer. Jour. Sci., 3d ser., vol. xxxv, 1888, pp. 120-143, 328-331, 367-388, 448-466, plate ii.

The three formations discussed are the Potomac (now divided into four formations), the Appomattox (Lafayette) and the Columbia (now divided into three formations.) These are described in far greater detail than had ever been done before and the conclusions reached vary but little from the views held at the present time.

McGEE, W J. The Columbia Formation.

Proc. Amer. Assoc. Adv. Sci., vol. xxxvi, 1888, pp. 221-222.

The Columbia formation overlying unconformably the Cretaceous and Tertiary deposits of the Atlantic Coastal Plain is said to consist of series of deltas and terraced littoral deposits. It is said to pass under the terminal moraine to the northward. The Columbia materials are supposed to have been laid down during a period of glaciation long preceding the glacial epoch during which time the terminal moraine was formed.

MARCOU, JULES. American Geological Classification and Nomenclature. 75 pp. Cambridge, Mass., 1888.

The writer mentions a specimen of *Eycad* found in association with pieces of petrified wood and broken bones "on the farm of Dr. Jenkins, one mile south of the Baltimore and Washington railroad, sixteen miles from Washington, Prince George's county, Maryland." He correlates the deposit in which the specimens were found with the Purbeck formation of England.

UHLER, P. R. The Albirupean Formation and its nearest relatives in Maryland.

Proc. Amer. Phil. Soc., vol. xxv, 1888, pp. 42-53.

Discussion by H. Carvill Lewis and A. Heilprin (pp. 53-54.)

In this article the writer proposed the name of "Baltimorean" for the basal Potomac deposits and "Albirupean" for the sands that overlie the basal beds and which are firmly indurated in several places in the State. One of the places where the sandstone is described is in "the vicinity of the fork of the Great Patuxent river, in Prince George's county." The pre-Tertiary deposits of the Coastal Plain are said to consist of the two formations named above and the marine greensands. In the discussion Professors Lewis and Heilprin disagreed with Dr. Uhler as they claimed he had included some Paleozoic quartzites with the mesozoic sandstones in the albirupean formation.

UHLER, P. R. Observations on the Eocene Tertiary and its Cretaceous Associations in the State of Maryland.

Trans. Md. Acad. Sci., vol. i, 1888, pp. 11-32.

Many details concerning the distribution, lithologic characteristics, and fossil content of the Eocene and Cretaceous deposits of this county are given.

WARD, LESTER F. Evidence of Fossil Plants as to the Age of the Potomac Formation.

Amer. Jour. Sci., 3d ser., vol. xxxvi, 1888, pp. 119-131.

From an examination of the fossil plants of the Potomac formation the author states that "the Potomac flora, viewed in all its bearings, cannot be said positively to negative the reference of the formation to the Jurassic upon the evidence of the plants alone."

1889.

BRYAN, O. N. The Cretaceous Formation of Southwestern Maryland.

Amer. Nat., vol. xxiii, 1889, pp. 713-714.

The Eocene and Cretaceous deposits in the vicinity of Fort Washington and Piscataway are briefly described and are said to be underlain by a lower formation which is thought to be of Jurassic age.

CLARK, WM. B. Discovery of Fossil-Bearing Cretaceous Strata in Anne Arundel and Prince George Counties, Maryland.

Johns Hopkins Univ. Circ., No. 69, vol. viii, 1889, pp. 20-21.

Fossiliferous Cretaceous strata are reported to occur in tributaries of the Patuxent River due east of Collington and at Fort Washington. Lists of fossils found at these places are given. This is the first mention of fossiliferous Cretaceous strata west of Chesapeake Bay. The beds are said to lie nearly horizontal.

FONTAINE, W. M. Potomac or Younger Mesozoic Flora.

Monograph U. S. Geol. Surv., vol. 15, Washington, 1889, 377 pp., 180 pls.

Contains a description of the Potomac deposits and the plant remains found in them. Many of the fossils were obtained in Prince George's county at Fort Washington, Beltsville and Contee and in the District of Columbia.

KNOWLTON, F. H. Fossil Wood and Lignites of the Potomac Formation. (Read before Amer. Assoc. Adv. Sci., 1888.)

Amer. Geol., vol. iii, 1889, pp. 99-106.

A brief description is given of the Potomac formation. Good exposures containing lignite and silicified wood are said to occur at Fort Washington, in the cities of Baltimore and Washington and at several points in Virginia. Detailed descriptions of the silicified wood and lignite are given.

KNOWLTON, F. H. Fossil Wood and Lignite of the Potomac Formation.

Bull. U. S. Geol. Surv. No. 56, Washington, 1889.

Contains a brief discussion of the distribution of the Potomac deposits and a detailed description of some species of fossil wood found in them.

MARSH, O. C. Geologic and Paleontologic Investigations in Maryland.

9th An. Rep't. U. S. Geol. Surv., 1887-88, Washington, 1889, pp. 114-115.

The statement is made that on the evidence obtained from fossils the Potomac formation has been "proved conclusively" to be "of Upper Jurassic age" and that it "contains a rich and varied fauna."

MCGEE, W J. The Geological Antecedents of Man in the Potomac Valley.

Amer. Anth., vol. ii, 1889, pp. 227-234.

The conditions prevailing during the times that the Potomac and Columbia deposits were being formed are described.

UHLER, P. R. Additions to Observations on the Cretaceous and Eocene Formations of Maryland.

Trans. Md. Acad. Sci., vol. i, 1889, pp. 45-72.

This paper contains many descriptions of Cretaceous and Eocene strata in this county together with a general description of these formations as represented in the entire State. A list is given of all Eocene fossils recognized up to that time.

WARD, LESTER F. The Geographical Distribution of Fossil Plants.

8th An. Rept. U. S. Geol. Surv., 1886-87, Washington, 1889, pt. ii, pp. 663-960, maps.

Several localities where fossil plants have been obtained from Potomac strata are mentioned. Beltsville is especially mentioned as where both fossil plants and remains of dinosaurs were found in an old iron mine.

1890.

CLARK, WM. B. Third Annual Geological Expedition into Southern Maryland and Virginia.

Johns Hopkins Univ. Cir. No. 81, vol. ix, 1890, pp. 69-71.

Contains a description of the Fort Washington bluff.

PATTERSON, HARRY J. Report of the Chemist.

2nd An. Rept. Md. Agri. Exper. Sta., College Park, 1890, pp. 67-94.

The different kinds of marls occurring in Maryland are described and analyses of many are given including two samples of marls from Upper Marlboro and two from Piscataway Creek.

UHLER, P. R. Notes and Illustrations to Observations on the Cretaceous and Eocene Formations of Maryland.

Trans. Md. Acad. Sci., vol. i, pp. 97-104.

The Fort Washington bluff and the Eocene and Miocene exposures at Upper Marlboro are described. The Cretaceous strata at the former locality are correlated with the lower and middle marl beds of New Jersey.

1891.

CLARK, WM. B. Correlation Papers — Eocene.

Bull. U. S. Geol. Surv., No. 83, Washington, 1891, 173 pp. 2 maps.

(Abst.) Johns Hopkins Univ. Cir. No. 103, vol. xii, 1893, p. 50.

Contains a discussion of all the literature concerning the Eocene of the United States published up to that time. The distribution and characteristics of the Maryland Eocene deposits are briefly described.

CLARK, WM. B. Report on the Scientific Expedition into Southern Maryland. (Geology, W. B. Clark; Agriculture, Milton Whitney; Archaeology, W. H. Holmes.)

Johns Hopkins Univ. Cir. No. 89, vol. x, 1891, pp. 105-109.

Contains a description of the Fort Washington bluff and also short descriptions of the distribution and lithologic characteristics of the Mesozoic and Cenozoic formations of the Coastal Plain.

DARTON, N. H. Mesozoic and Cenozoic Formations of Eastern Virginia and Maryland.

Bull. Geol. Soc. Amer., vol. ii, 1891, pp. 431-450, map sections.

(Abst.) Amer. Geol., vol. vii, 1891, p. 185.

(Abst.) Amer. Nat., vol. xxv, 1891, p. 658.

Contains a description of the Potomac, Severn (Marine Cretaceous), Pamunkey (Eocene), Chesapeake (Miocene), and Appomattox (Lafayette) formations as known at that time.

LINDENKOHL, A. Notes on the submarine channel of the Hudson River and other evidences of Postglacial Subsidence of the Middle Atlantic Coast Region.

Amer. Jour. Sci. 3rd ser., vol. xli, 1891, pp. 489-499, pl. xviii.

Some statements are made concerning the submerged channel of the Potomac River.

MCGEE, W J. The Lafayette Formation.

12 An. Rept. U. S. Geol. Surv., part i, 1890-91.

Washington, 1891, pp. 347-521.

The general characteristics of the entire Coastal Plain and of each of the formations composing it are discussed at length.

McGee, W J, Williams, G. H., Willis, Bailey, and Darton, N. H. Geology of Washington and Vicinity. In Guide to Washington and its Scientific Institutions. Compte rendu, International Congress of Geologists, 1891.

House Misc. Doc., 53rd Cong., 2nd sess. vol. xiii, No. 107, pp. 219-251.

Contains descriptions of physiographic and geologic features in the vicinity of Washington and a general description of the entire Coastal Plain.

Patterson, Harry J. Report of the Chemist.

3rd An. Rep. Md. Agri. Exper. Sta., College Park, 1891, pp. 118-129.

The analyses of eight samples of marls from Seat Pleasant are given.

White, C. A. Correlation papers. Cretaceous.

Bull. U. S. Geol. Surv. No. 82, 1891, 273 pp., 3 pl.

House Misc. Doc., 52nd Cong., 1st sess., vol. xx, No. 25.

Contains brief descriptions of the distribution and characteristics of the marine and non-marine Cretaceous strata of the State.

Woolman, Lewis. Artesian wells and water-bearing horizons of Southern New Jersey (with a "note on the extension southward of diatomaceous clays, and the occurrence there of flowing artesian wells.")

New Jersey Geol. Surv., Rep't. State Geologist for 1890, Trenton, 1891, pp. 269-276.

The diatomaceous earth bed outcropping in the vicinity of Nottingham is mentioned. It is said to contain the diatom *Heliopelta*. This bed is thought to extend continuously from New Jersey to North Carolina.

1892.

Clark, Wm. B. The Surface Configurations of Maryland.

Monthly Rept. Md. State Weather Service, vol. II, 1892, pp. 85-89.

General summary of the physical features of the State.

Dall, W. H., and Harris, G. D. Correlation Papers—Neocene.

Bull. U. S. Geol. Surv. No. 84, 1892, 349 pp., 3 maps, 43 figures.

House Misc. Doc., 52nd Cong., 1st sess., vol. xliii, No. 337.

Contains a full discussion of all the literature of the Miocene and Pliocene of the United States published up to that time. Tentative correlations are made.

Patterson, H. J. Report of the Chemist.

4th An. Rep. Md. Agri. Exper. Sta., 1891, Annapolis, 1892, pp. 297-346.

Analyses are given of Eocene marls from Upper Marlboro, Seat Pleasant, and T. B. and of a Cretaceous marl sample from Seat Pleasant.

SCHARF, J. THOMAS. The Natural Resources and Advantages of Maryland, being a complete description of all the counties of the State and the City of Baltimore. Annapolis, 1892.

Contains a general geographic description of Prince George's county with brief statements of the mineral products.

UHLER, P. R. Albirupean Studies.

Trans. Md. Acad. Sci., vol. i, 1890-92, pp. 185-202.

The Albirupean and Potomac formations are described in detail and many references made to localities in this county. Much of Uhler's Albirupean formation is now referred to the Magothy, particularly the lignitic black clays while parts are included in the Potomac group.

WILLIAMS, G. H., and CLARK, WM. B. Report on short excursions made by the Geological Department of the University during the Autumn of 1891.

Johns Hopkins Univ. Cir. No. 95, vol. xi, 1892, pp. 37-39.

The section of Potomac, Marine Cretaceous, Eocene, and Pleistocene strata exposed at Fort Washington is briefly described.

1893.

CLARK, W. B. Physical Features [of Maryland]. Maryland, its Resources, Industries, and Institutions. Baltimore, 1893, pp. 11-54.

Contains short descriptions of the topography, climate, water supply, and water power of the different portions of the State.

DARTON, N. H. The Magothy Formation of Northeastern Maryland.

Amer. Jour. Sci., 3d ser., vol. xiv, 1893, pp. 407-419, map.

The Magothy formation is differentiated from other Cretaceous strata with which the deposits had previously been included. The distribution and characteristics of the formation are discussed and many local details described. A map showing the distribution of the formation is given.

HILL, ROBERT T. Clay Materials of the United States. Mineral Resources United States, 1891. Washington, 1893.

Brief mention is made of the Columbian and Potomac clays of the county and of the District of Columbia.

KEYSER, W. Iron. Maryland, its Resources, Industries and Institutions, pp. 100-112. Baltimore, 1893.

An historical discussion of the iron industry in Maryland.

WHITNEY, MILTON. Description of the Principal Soil Formations of the State [Maryland]. Maryland, its Resources, Industries and Institutions. Baltimore, 1893, pp. 181-211.

Contains descriptions of the soils of the State, their distribution, origin, and adaptabilities.

WHITNEY, MILTON. The Soils of Maryland.

Md. Agri. Exper. Sta. Bull. No. 21, College Park, 1893, 58 pp., map.

The principal soils of the State are described and their adaptability to different kinds of crops discussed. A map is given showing their general distribution.

WILLIAMS, G. H. Mines and Minerals of Maryland.

Maryland, its Resources, Industries and Institutions, Baltimore, 1893, pp. 89-153.

Reference is made to the Eocene greensand marls of the county.

WILLIAMS, G. H., and CLARK, W. B. Geology of Maryland.

Maryland, its Resources, Industries and Institutions, Baltimore, 1893, pp. 55-89.

The different geological formations recognized at that time are briefly described. Several important Eocene and Cretaceous fossiliferous localities in this county are mentioned.

1894.

DARTON, N. H. Outline of Cenozoic History of a Portion of the Middle Atlantic Slope.

Jour. Geol., vol. ii, 1894, pp. 568-587.

A description of the formations of the Atlantic Coastal Plain and a resumé of the geological history of the region.

DARTON, N. H. Artesian Well Prospects in Eastern Virginia, Maryland, and Delaware.

Trans. Amer. Inst. Min. Eng., vol. xxiv, 1894, pp. 372-397, pls. i-ii.

Contains a general description of the Atlantic Coastal Plain formations with records of some of the important artesian wells of Eastern Maryland and Virginia with a discussion of artesian water conditions in those areas. Record of a 384-foot well at Bowie is given.

HARRIS, G. D. On the Geological Position of the Eocene Deposits of Maryland and Virginia.

Amer. Jour. Sci., 3rd ser., vol. xlvii, 1894, pp. 301-304, figs. 1-3.

The writer correlates the Eocene of Virginia and Maryland with the Bell's Landing substage of Alabama.

MARYLAND STATE WEATHER SERVICE. The Climatology and Physical Features of Maryland.

1st Bien. Rep. Maryland State Weather Service for years 1892-1893. Baltimore, 1894.

A general discussion of the geology, topography, soils and climate of the State.

NEWELL, F. H. Results of Stream Measurement.

14th An. Rep. U. S. G. S., 1892-1893, part ii, pp. 89-155.

Gives data concerning the Potomac River near Washington.

WARD, L. F. Fossil Cycadean Trunks of North America, with a Revision of the Genus Cycadcoidea Buckland.

Proc. Biol. Soc., Washington, vol. ix, pp. 75-88.

The species of cycads found in the Potomac deposits of Maryland are included in the list of forms given.

WARD, L. F. Recent Discoveries of Cycadean Trunks in the Potomac Formation of Maryland.

Bull. Torry Bot. Club, vol. xxi, 1894, pp. 291-299.

A short account is given of the cycad remains found in the Potomac deposits of Maryland and the manner in which a collection of them has been brought together. The region about Muirkirk has furnished more specimens than any other locality in the Atlantic Coastal Plain.

1895.

ANONYMOUS. Vert. Fauna of Potomac Formation in Maryland.

Science, N. S., vol. i, 1895, pp. 362.

Notice of a collection of reptilian remains from the vicinity of Muirkirk made by A. Bibbins.

BIBBINS, ARTHUR. Notes on the Paleontology of the Potomac Formations.

Johns Hopkins Univ. Circ., vol. xv, 1895, pp. 17-20.

The author describes the occurrence of cycads and other plant remains in the Potomac deposits of Maryland. The Contee and Muirkirk localities are described in detail.

CLARK, W. B. Cretaceous Deposits of the Northern Half of the Atlantic Coastal Plain.

Bull. Geol. Soc. America, vol. vi, 1895, pp. 479-482.

The Matawan and Navesink formations are said to occur in Prince George's county.

CLARK, WILLIAM B. Descriptions of the Geological Excursions made during the Spring of 1895.

Johns Hopkins Univ. Circ., vol. xv, 1895, pp. 1-2.

Brief descriptions of all the Coastal Plain formations are given while the strata exposed in the bluffs at Fort Foote and Fort Washington are mentioned.

CLARK, WM. B. Contributions to the Eocene Fauna of the Middle Atlantic Slope.

Johns Hopkins Univ. Circ., vol. xv, 1895, pp. 3-6.

The author makes the following statement: "I am, therefore, strongly of the opinion, upon both geological and paleontological grounds, that the Eocene deposits of the Middle Atlantic slope represent the greater portion of the Eocene series of the Gulf, its highest members alone excepted." Many localities in Maryland and Virginia are given where Eocene fossils have been obtained and many new species are described.

MERRILL, GEORGE P. Disintegration of the Granitic Rocks of the District of Columbia.

Bull. Geol. Soc. America, vol. vi, 1895, pp. 321-332, pls. 16.

Describes the weathering of foliated micaceous granite in the northwestern portion of the District of Columbia.

MERRILL, G. P. The Formation of Sandstone Concretions.

Proc. U. S. National Museum, vol. xvii, 1895, pp. 87-88, pl.

The writer describes some concretions from the Potomac deposits.

WARD, LESTER F. The Potomac Formation.

15th An. Rep. U. S. G. S., Washington, 1895, pp. 307-397, 3 pls., 5 figs.

General description of the Potomac deposits as known at that time. Maryland details of the strata in this county are given.

1896.

CLARK, W. B. The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland, and Virginia.

Bull. U. S. G. S. No. 141, 167 pp., 40 pl.

An exhaustive study of the Eocene in which the stratigraphy and paleontology of the deposits are discussed in detail.

CLARK, W. B. The Potomac River Section of the Middle Atlantic Coast Eocene.

Amer. Jour. Sc., 4th ser., vol. i, 1896, pp. 365-374.

Sections along the Potomac River are given and the characteristics of the Maryland and Virginia Eocene deposits described. The writer states that "the Middle Atlantic Slope Eocene represents in a broad way all or the major part of the Lignitic, Buhrstone and Claiborne of Smith . . . and perhaps even more."

DARTON, N. H. Artesian Well Prospects in the Atlantic Coastal Plain Region.

Bull. 138, U. S. G. S., 232 pp., 19 pls.

Contains a brief description of the Coastal Plain formations of the State with a discussion of their water-bearing powers. Records are given of a 150-foot well at Agricultural College, of a 384-foot well at Bowie, and a 148½-foot well near Laurel, and a 222-foot well at Marlboro.

FONTAINE, W. M. Potomac Formation in Virginia.

Bull. U. S. G. S., 145, 149 pp., 2 pls.

Brief descriptions of the Potomac deposits of Maryland given. Two series of strata are said to occur in Maryland. From a study of the flora the Potomac is said to be of Middle or Lower Neocomian age.

MARCOU, JULES. The Jura in the United States.

Science, n. s., vol. iv, 1896, pp. 945-947.

Agrees with Marsh that the Potomac deposits belong to the Upper Jurassic.

MARSH, O. C. The Jurassic Formation on the Atlantic Coast.

Science, n. s., vol. iv, pp. 805-816.

The author maintains the Jurassic age of the Potomac deposits.

MARSH, O. C. The Dinosaus of North America.

16th An. Rep. U. S. G. S., part i, pp. 195-413, 84 pls., 66 figs.

Dinosaurian remains from the Potomac deposits of Prince George's county are described and figured.

WARD, LESTER F. Some Analogies in the Lower Cretaceous of Europe and America.

16th An. Rep. U. S. G. S., part i, pp. 463-542, pls. 97-107.

From a comparison of the floras the writer correlates the Potomac strata with the Wealden of England.

WARD, L. F. Age of the Island Series.

Science, n. s., vol. iv, pp. 757-760.

The author brings forward additional evidence to prove that the Potomac deposits belong to the Lower Cretaceous.

1897.

CLARK, W. B. Outline of the Present Knowledge of the Physical Features of Maryland, Embracing an Account of the Physiography, Geology, and Mineral Resources.

Md. Geol. Survey, vol. i, 1897, pp. 141-228, pls. 6-13.

Contains a description of all the geologic formations of the State recognized at that time.

CLARK, W. B., with R. M. BAGG, and G. B. SHATTUCK. Upper Cretaceous Formations of New Jersey, Delaware and Maryland.

Bull. Geol. Soc. of America, vol. viii, 1897, pp. 315-358, pls. 40-50.

Contains a full description of each of the Marine Cretaceous formations of the Northern Atlantic Coastal Plain.

CLARK, W. B., and BIBBINS, ARTHUR. The Stratigraphy of the Potomac Group in Maryland.

Jour. Geol., vol. v, 1897, pp. 479-506.

Contains a general description of the Potomac deposits of the State which are divided for the first time into four formations, viz: Patuxent, Arundel, Patapsco and Raritan.

1898.

BAGG, R. M., JR. The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope.

Amer. Pal. Bull., vol. ii, No. 10, Ithaca, 1898, 54 pp., 3 pls.

The following forms are described from the Eocene deposits at Upper Marlboro: *Textularia sagittula*, *Nodosaria consobrina var. emaciata* and *Nodosaria communis* and *Vaginulina legumen* from Sunnyside.

BAGG, RUFUS MATHER. The Occurrence of Cretaceous Fossils in the Eocene of Maryland.

Amer. Geol., vol. 22, 1898, pp. 370-375.

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The views of McGee, Darton, and Salisbury concerning the Pleistocene deposits are summarized and compared with the writer's views. The wave-built terrace deposits are referred to four different formations, the Talbot, Wicomico, Sunderland, and Lafayette, the first three of which constitute the Columbia group. These formations are said to be separated by erosional unconformities.

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Md. Geol. Surv., Pliocene and Pleistocene, pp. 21-137, plates, Baltimore, 1906.

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Bulletin Torrey Bot. Club, vol. xxxiii, pp. 163-182, pl. 7-9.

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WIELAND, G. R. American Fossil Cycads.

Carnegie Inst., Washington, Pub. No. 34, 4 to 296 pp., 138 figs, 50 pls., 1906.

The cycads found in the Potomac beds of Maryland are mentioned while the structure, growth, and relationships of cycads are discussed in great detail.

1907.

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THE PHYSIOGRAPHY OF PRINCE GEORGE'S COUNTY

BY

BENJAMIN L. MILLER

Introductory.

Maryland is divisible into three grand physiographic provinces, each with certain distinguishing characteristics. These provinces are, beginning with the most easterly, the Coastal Plain, the Piedmont Plateau, and the Appalachian Region.

These three provinces form bands of somewhat varying width that extend in a northeast-southwest direction, roughly parallel to the shore line, from New England to the Gulf of Mexico. All three are typically represented in Maryland. Garrett, Allegany and Washington counties form a part of the Appalachian Region; Frederick, Carroll, Montgomery, Howard, and the northern and northwestern portions of Baltimore, Harford and Cecil counties lie within the Piedmont Plateau; while the remaining portion of the State constitutes a part of the Coastal Plain province.

The elevations, the characteristics of the streams, and the lithologic character and structure of the rocks serve as criteria for the separation of these three provinces. In some places, however, there is such a gradation from one to the other that some difficulty is encountered in drawing the exact boundary line. Passing from the coast westward, the country rises at first gradually until the eastern border of the Piedmont Plateau is reached, then more rapidly to the Blue Ridge which marks the western boundary of the Piedmont Plateau, and finally in the Appalachian Region the summits of the Appalachian Mountains are reached in the western portion of the State. The streams of the three provinces are essentially different. The estuaries of the Coastal Plain, occupying broad open valleys form a

striking contrast to the swift streams of the other two provinces which flow in steep rock-walled gorges; while the superimposed, meandering streams of the Piedmont Plateau are markedly unlike the Appalachian streams which flow in structural valleys. But probably the greatest distinction between the three provinces is due to the character of the rocks. The unconsolidated sediments of the Coastal Plain, dipping gently toward the ocean, are sharply separated from the contorted metamorphosed igneous intruded strata of the Piedmont Plateau, while these in turn can be readily differentiated from the unmetamorphosed Appalachian Region limestones and sandstones which have been thrown into broad, open folds, forming longitudinal ridges and valleys with a northeast-southwest trend.

Prince George's County lies almost entirely within the eastern province and is known as a Coastal Plain county, although its extreme western portion forms a part of the Piedmont Plateau.

Topographic Description.

As previously stated, Prince George's County contains portions of two great physiographic provinces which have characteristic topographic features. The topography of the Piedmont Plateau in this county, however, is not characteristic of the general topography of the province for the reason that it has been greatly modified by the Coastal Plain deposits overlying it. It is represented only in the uplands west and northwest of Washington and in small areas along the western border of the county between Washington and Laurel. Within the area under discussion the northwest portion of the District of Columbia shows the best examples of Piedmont Plateau topography. Here occur many hills, irregular in outline with rounded flat-topped summits separated from each other by steep, precipitous valleys. Those hills without coverings of Coastal Plain sediments are seldom flat-topped but instead slope gradually in all directions for a short distance from the highest point, and then very rapidly to the streams occupying the narrow gorge-like valleys.

In the Coastal Plain portion of the county the flat-topped stream divides separated by broad open valleys afford a striking contrast to the topography of the Piedmont Plateau. The broad tidal estuaries

that extend inland to the eastern border of the Piedmont Plateau are the most prominent characteristics of the Coastal Plain of Maryland. On the eastern side of Chesapeake Bay these streams are occupied by tide-water almost to their heads while the tributary streams are also very little above tide, consequently stream erosion has accomplished very little work and the country is in the main extremely flat. On the western shore different conditions prevail as here the larger streams are estuaries up as far as the "Fall-line," but the heads of the tributaries lie a few hundred feet above tide and hence they have been able to do considerable erosion. For this reason the topography of the western shore Coastal Plain is much more diversified than that of the Eastern Shore, Prince George's County exhibiting a topography of the western-shore type.

The elevations in Prince George's County range from the level of tide-water in the estuaries to slightly more than 420 feet above sea level. The highest point is a small hill near the Montgomery County line a short distance southwest of Laurel. At Tenley(town) in the District of Columbia a hill rises to the height of 400 feet. Both of these hills are found in the Piedmont Plateau province, although the capping of the hills is Pleistocene sand and gravel. From the Piedmont Plateau border the stream divides slope gently to the southeast, where they have an average elevation of about 140 feet. If the stream valleys were filled up the result would be a gently sloping country with an average of about 7 feet per mile, a grade so low as to be practically unnoticeable, thus causing the region to appear as a flat monotonous plain. It is in this very gently sloping country that the Potomac and Patuxent rivers and their tributary streams have cut their drainage channels and have by so doing developed a somewhat diversified topography.

The ease with which different strata or formations are worn away by erosion is usually the most important factor in the determination of the topographical configuration of any region. It is this which is mainly responsible for the direction of the streams and for the relative elevations, especially in a region which has not been subjected to orogenic movements and where, as a result, the strata are approximately horizontal.

In the Piedmont Plateau the topography is mainly due to these facts and almost invariably the broader valleys have been developed in limestone regions while the ridges are composed of less easily eroded rocks. In the Coastal Plain where the strata are almost entirely composed of unconsolidated sediments there is in general little difference in the rate at which erosion proceeds. However, it can be seen in several places that the Potomac strata are generally easily eroded because of the large amount of sand present.

As a result of the difference in the ease of erosion of the Potomac strata a strike valley occupied by Anacostia River and its tributaries has been produced in this region. The valley is carved out of Potomac sands and clays and is confined between the crystalline rocks of the Piedmont Plateau on the west and the younger formations of the Upper Cretaceous and Tertiary on the east. Contrary to what might be expected the eastern wall of this valley is even steeper than the western. This is especially noticeable in the southeastern portion of the District of Columbia.

The most prominent feature in connection with this difference in case of erosion has been its effect upon the direction of the streams in the area in which the Potomac strata form the surface formations. A glance at the map will show that the escarpment between the Lower and Upper Cretaceous rocks has served as an efficient divide between two sets of secondary streams. In only one instance in this county does a secondary stream flowing mainly through the area of the later formations drain any Potomac area. The Western Branch is the sole exception as it has cut through the escarpment just west of Woodmoor. The larger volume of water carried by the Western Branch has aided this stream in pushing its head backward into the Potomac area.

It is also probable that the ease with which the Potomac material is eroded is responsible for the change in direction of the Potomac River where it emerges from the crystalline rocks. This stream traverses the Piedmont Plateau in a general southeasterly course regardless of the character of the country rock, but as soon as it strikes the Potomac strata it changes its course suddenly and flows southward in a direction almost parallel to the strike. This direc-

FIG. 1.—VIEW ALONG PAINT BRANCH, SHOWING THE ROCKY CHANNEL CHARACTERISTIC OF PIEDMONT STREAMS.

FIG. 2.—VIEW OF PATUXENT RIVER AT PRIEST BRIDGE, SHOWING THE LOW MUDDY VEGETATION-COVERED BANKS CHARACTERISTIC OF COASTAL PLAIN STREAMS.

tion it maintains beyond the limits of the area under discussion, though it does finally resume its southeastern course, cutting across the Tertiary strata to Chesapeake Bay.

TOPOGRAPHIC FEATURES.

Prince George's County as a whole exhibits five general topographic features, which are usually very distinct. These vary greatly in the amount of surface that they occupy, but the most noticeable distinction is that they lie at different elevations.

Tide Marshes.—The first of these topographic features to be described consists of the tide marshes found in the valleys of most of the larger estuaries, particularly of Patuxent and Anacostia rivers and Piscataway Creek. These extend over a number of square miles and lie at a level so low that the tides frequently submerge them in part. The small streams that empty into many of the estuaries meander through these marshes, which are rapidly encroaching on them. These marshes are filled with a growth of sedges and other marsh plants, which aid in filling up the depressions by serving as obstructions to retain the mud carried in by streams and by furnishing a perennial accumulation of vegetable débris.

Lafayette Plain.—The Lafayette plain is the highest of the plains developed within the Coastal Plain province. It has a considerable extent in this county southeast of Anacostia, forming the divide between the valley of Patuxent River on the east and the basin of Potomac River on the west. Throughout this region the margin of the Lafayette plain has been extensively removed by stream action, but the central portions have been practically undisturbed.

Sunderland Plain.—The Sunderland plain lies at a higher elevation than the Wicomico and extends from about 100 feet to about 200 feet above sea level. It is usually separated from the Wicomico plain by an escarpment, and in most places another escarpment marks its contact with the next plain above. The escarpment separating the Wicomico from the Sunderland plain is one of the most striking and constant topographic features in the Coastal Plain of Maryland.

It occupies the highest portions of the divide between Chesapeake Bay and Patuxent River and also is well developed along the western side of Patuxent Valley as far north as the mouth of Western Branch. In the valleys of Mattawoman, Piscataway and Henson creeks and Anacostia River the Sunderland plain, though present, is represented only by remnants. The surface of this plain reaches an altitude of about 180 feet at Charlotte Hall, a short distance beyond the southern boundary of Prince George's County, and of 200 feet near Anacostia. It has suffered more stream erosion than the Talbot and Wicomico plains, which lie at lower levels.

Wicomico Plain.—The Wicomico plain lies at a higher level than the Talbot, from which it is in many places separated by an escarpment varying in height from a few feet to 10 or 12 feet. At some places this escarpment is absent, so that there seems to be a gradual passage from the Talbot plain to the Wicomico. It is present, however, at so many different places that there is little difficulty in determining the line of separation between the two plains. The base of the escarpment lies at an elevation of about 40 feet. From that height the Wicomico plain extends upward to an elevation of about 100 feet, where it is in turn separated from the next higher plain by an escarpment.

The Wicomico plain is older than the Talbot and has suffered more erosion. The streams which cross it have cut deeper valleys than those in the Talbot plain and have widened their basins to such an extent as to destroy, in great measure, the original continuity of its level surface. Enough of this surface remains, however, to indicate the presence of the plain and to permit its identification.

The escarpment which separates this plain from the Sunderland plain below is well defined in the region about Anacostia, where it attains a height of about 50 feet. Near Aquasco, and just beyond the southern border of the county in the vicinity of Charlotte Hall, the escarpment is present, but here it does not exceed 20 feet in height. Throughout the rest of the County it seems never to have existed or to have been destroyed or so greatly modified by erosion that its determination is rendered uncertain. The surface of this plain ranges in elevation from about 200 feet in the southeastern

portion of the county to about 300 feet in the hills southeast of Washington.

Talbot Plain.—The Talbot plain borders the tide marshes and extends from sea level to an altitude of about 45 feet. It is present throughout the county along the larger streams. In the valley of the Patuxent River this plain is characteristically developed. Here it extends in an almost continuous belt from the southern margin of the county to Hills Bridge, growing gradually narrower as it ascends the streams and broken only by the shallow valleys of small streams which cut across it in their course to Patuxent River. North of Hills Bridge and on the western branch of the Patuxent, the Talbot plain is present only in scattered remnants. In the western portion of the county this plain is well developed in the lower valleys of Piscataway and Henson creeks, and occurs in an unbroken flat extending up the valley of Anacostia River as far as College Park. The Talbot plain has been dissected by stream action less than any of the other plains described below.

THE DRAINAGE OF PRINCE GEORGE'S COUNTY.

The drainage of Prince George's County is comparatively simple, as a result of the simple structure of the Coastal Plan formations and the contiguity of the region to Chesapeake Bay. While practically all portions of the County are naturally drained there are numerous small areas in which there is little surface drainage. Such areas are most common on the wide stream divides near Brandywine. Numerous small upland swamps from which the surface water escapes only through percolation or evaporation occur in this vicinity. In the northwestern portion of the county where the stream divides are very narrow the only undrained regions are the tide-water marshes already described.

Stream Divides.—In the examination of the stream divides of Prince George's County two peculiarities attract attention. The first is their relative widths and the second their asymmetrical development. In the southern portion of the County where the Lafayette

plain is so well developed the flat-topped divides are in several instances as much as two miles in width, while in the northern portion they are seldom more than one-half mile wide. The difference is due to the relative ease with which the different strata are eroded as the geologic map shows the narrow divides in the Potomac strata and the wide ones in the regions where the Tertiary formations outcrop. The asymmetry of the drainage is shown in the greater length of the secondary streams flowing into the Potomac as compared with the Patuxent tributaries. In Charles and St. Mary's counties the streams on the Patuxtent River slope are very short and numerous as compared with the fewer, longer, and larger tributaries on the Potomac side, and in Calvert County the Chesapeake drainage slope receives the small streams while the Patuxent River the large ones. Thus the westerly-flowing streams seem to have been able to advance their headwaters faster than the ones flowing in the opposite direction. In Prince George's County the same conditions prevail, though in a much less exaggerated form. However, the sinuous divide between the Patuxent and Potomac drainage basins is readily seen to lie adjacent to the Patuxent River. This asymmetry would be more marked were it not for the Western Branch, which extends its head so far from the parent stream.

At the present time because of the tributaries of the Patuxent being shorter and more direct than those of the Potomac, erosion is more vigorous in the former basin than the latter, with the result that the divide is being pushed rapidly toward the Potomac River.

Tide-water Estuaries.—The lower courses of almost all the larger streams emptying into Chesapeake Bay have been converted into estuaries through a submergence which has permitted tide water to pass up the former valleys of the streams. In the early development of the country these estuaries were of great value, as they are navigable for many miles from their mouths and thus afford means for ready transport of the produce of the region to market. Even the advent of railroads has not rendered them valueless and much grain and fruit are now shipped to market on steamers and small sailing vessels which traverse these estuaries. Chesapeake Bay and its tributary estuaries also furnish good fishing grounds, and during

certain seasons they are frequented by wild waterfowl in such numbers that they have long been known to sportsmen as among the finest hunting grounds in the country. The water in the estuaries is fresh or very slightly brackish, and ebbs and flows with the tide. There is seldom any distinct current to be noticed and such as is seen is due to the incoming or outgoing tide and appears to be nearly as strong when moving upstream as when moving in the opposite direction.

The Potomac River.—The Potomac River is the most important stream to be mentioned in connection with the drainage of Prince George's County. It forms about half of the western boundary of the County and receives, through its numerous tributaries the drainage of about two-thirds of the area. The Potomac is an estuary up as far as Georgetown and is navigable almost to the head of tide water. Steamboats carrying freight and passengers ply between Washington and Chesapeake Bay ports, particularly Norfolk and Baltimore, though the modern high-draft war and ocean-going vessels cannot reach the city, and thus the Navy Yard at Washington ceases to fulfil the expectations of the founders of the capital.

The estuary of the Potomac is from one-half to one mile in width along the borders of the County and gradually increases in width to about 13 miles at its mouth. The current is very slight and with the rising tide the water flows upstream. Almost the only rocks present are occasional loose boulders which have been washed out of the Pleistocene deposits along the shores or have been transported from the Piedmont Plateau by floating ice. The banks are usually low though occasional bluffs of considerable height border the river. In this region the bluff on which Fort Washington stands is the highest and rises with very steep slopes over 100 feet above the water.

At Georgetown the crystalline rocks pass beneath the water and this marks the head of tide water. Westward the stream gradient is much steeper, the river is narrower, the current is rapid, the bed of the stream is filled with boulders or ledges of rock, and the enclosing walls are of hard rock rising, in many places, almost perpendicularly from the water's edge.

The Potomac River receives many tributaries which drain portions of the county. Anacostia River, Oxon Run, Broad and Piscataway creeks, all of which are estuaries in their lower portions, are the most important. The heads of their estuaries are all being gradually filled by the materials brought down by their headwaters and by the accumulation of vegetable débris of marsh grasses which thrive in the shallow waters. Since the settlement of the region all of these streams have shown an appreciable amount of shoaling and navigation is now restricted to a very short distance from their junctions with the Potomac River. At present Anacostia River is not navigable above the bridge between the Navy Yard and Anacostia, while Piscataway Creek is navigable as far up as Farmington Landing and that only at high tide.

The Patuxent River.—The Patuxent River forms the boundary of Prince George's County on the east and northeast sides. In most respects this stream is very much like the Potomac. Like it, it descends from the Piedmont Plateau as a rather swift-flowing stream in a rocky channel and quickly changes its character to a sluggish stream with banks of mud so soon as it enters the Coastal Plain. This change takes place at Laurel, where the crystalline rocks of the Piedmont Plateau disappear beneath the covering of unconsolidated sediments. In the Patuxent River tide water does not extend up to the inner margin of the Coastal Plain as in the Potomac.

The channel of that portion of Patuxent River bordering Prince George's County is about 16 feet deep in the southern portion and shallows gradually to Leon, which is the head of steamboat navigation. The river is bordered by marshy areas in many places through which the stream meanders in broad, open loops.

Of the tributaries of the Patuxent River the Western Branch is the only one of any considerable importance. This stream drains a large area in the northern part of the County. Mataponi, Rock, Black Swamp, and Swanson creeks drain most of the southeastern portion of the County.

TOPOGRAPHIC HISTORY.

The history of the development of the topography as it exists today is not complicated. The topographic features were formed at several different periods, during all of which the conditions must have been very similar. The physiographic record is merely the history of the development of the four plains already described as occupying different levels, and of the present drainage channels. The plains of Prince George's County are primarily plains of deposition which, since their formation, have been more or less modified by the agencies of erosion. Their deposition and subsequent elevation to the heights

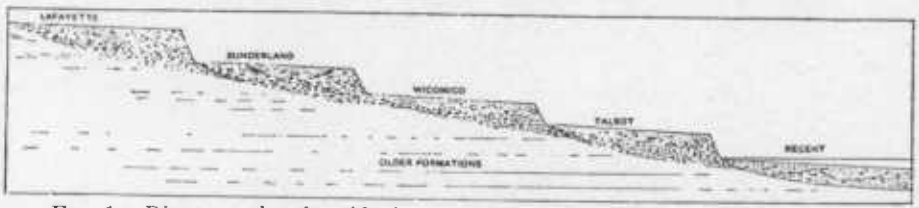


FIG. 1.—Diagram showing ideal arrangement of the various terrace formations in the Maryland Coastal Plain.

at which they are now found indicate merely successive periods of depression and uplift. The drainage channels have throughout most of their courses undergone many changes; periods of cutting have been followed by periods of filling, and the present valleys and basins are the results of these opposing forces.

The Lafayette Stage.—Within the borders of the County there are evidences of frequent changes during Cretaceous and early Tertiary time which resulted in the deposition of a succession of formations composed of heterogeneous materials. These changes, however, were to only a very slight extent influential in producing the present topography, so that in beginning the discussion of the physiographic history of the region they may be omitted. Toward the close of the Tertiary, however, a change in conditions occurred which is clearly shown in the existing topography. A layer of gravels, sands, and clays was spread over the entire Coastal Plain and along the borders of the Piedmont Plateau during the Lafayette submergence. These deposits, which, as already stated, must have been laid down on a

rather irregular surface, formed a thin mantle of materials, ranging from 25 to 50 feet in thickness. When the uplift which terminated Lafayette deposition occurred, a very even, gently sloping plain extending from the Piedmont Plateau to the ocean, bordered the continent. Across this plain, which was composed of coarse, unconsolidated materials, streams rising in the Piedmont gradually extended their courses, while new ones confined to the Coastal Plain were also developed. At this time the shore line seems to have been farther east than now, and the present submerged channels of the continental shelf were probably then eroded. The Coastal Plain portions of Delaware River, with its extension Delaware Bay; Chesapeake Bay, which is the continuation of Susquehanna River; and Potomac, Patuxent, Rappahannock, James, and other rivers date from this post-Lafayette uplift. The attitude of the subsequent deposits makes this evident, for the Sunderland, Wicomico, Talbot, and Recent terrace formations all slope toward these various waterways. The Lafayette formation was cut through by the streams, and valleys were opened in the older deposits. Several of these valleys became many miles wide before the corrasive power of the streams was checked by the Sunderland submergence.

The Sunderland Stage.—As the Coastal Plain was depressed, in early Pleistocene time, the ocean waters gradually extended up the river valleys and over the lower lying portions of the stream divides. The waves worked on the Lafayette-covered divides and removed the mantle of loose materials, which were either deposited farther out in the ocean or dropped in the estuaries formed by the drowning of the lower courses of the streams. Sea cliffs produced on points exposed to wave action were gradually pushed back as long as the sea continued to advance. These cliffs are now represented by the escarpment separating the Sunderland from the Lafayette. The materials which the waves gathered from the shore, together with other materials brought in by the streams, were spread out in the estuaries and constitute the Sunderland formation.

The tendency of the work done was to destroy all irregularities produced during the post-Lafayette erosion interval. In many places old stream courses were undoubtedly obliterated, but the

FIG. 1.—VIEW SHOWING INDURATED LEDGES OF THE PATUXENT FORMATION, W STREET, NEAR TWELFTH STREET, WASHINGTON, D. C.

FIG. 2.—VIEW SHOWING FLOODED IRON MINE IN THE ARUNDEL FORMATION NEAR MELRKIRK.

channels of the larger streams, although probably in some places entirely filled, were in the main left lower than the surrounding regions. Thus in the uplift following Sunderland deposition the larger streams reoccupied practically the same channels they had carved out in the preceding erosion period. They at once began to clear their channels and to widen their valleys, so that when the next submergence occurred the streams were eroding, as before, in Tertiary and Cretaceous materials. On the divides also the Sunderland was gradually undermined and worn back.

The Wicomico Stage.—When the Coastal Plain had been above water for a considerable time after the close of Sunderland deposition a gradual submergence again occurred, so that the ocean waters once more encroached on the land. This submergence seems to have been about equal in amount throughout a large portion of the district, showing that the downward movement was without deformation. The sea did not advance upon the land as far as it did during the previous submergence. At many places along the shore the waves cut cliffs into the deposits that had been laid down during the preceding epoch of deposition. Throughout many portions of the Coastal Plain at the present time these old sea cliffs are still preserved as escarpments, ranging from 10 to 15 feet in height. Where the waves were not sufficiently strong to enable them to cut cliffs it is somewhat difficult to locate the old shore line. During this time a large portion of Prince George's County was submerged. The Sunderland deposits were largely destroyed by the advancing waves and redeposited over the floor of the Wicomico sea, although those portions which lay above 90 to 100 feet were for the most part preserved.

Although the Wicomico submergence permitted the silting up of the submerged stream channels, yet the deposits were not thick enough to fill them entirely. Accordingly, in the uplift following Wicomico deposition the large streams reoccupied their former channels, with perhaps only slight changes. New streams were also developed and the Wicomico plain was more or less dissected along the water courses, the divides being at the same time gradually narrowed. This erosion period was interrupted by the Talbot sub-

mergence, which carried part of the land beneath the sea and again drowned the lower courses of the streams.

The Talbot Stage.—The Talbot deposition did not take place over so extensive an area as was covered by that of the Wicomico. It was confined to the old valleys and to the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the waves advanced, and now stand as an escarpment that marks the boundaries of the Talbot sea and estuaries. This is the Talbot-Wicomico escarpment, previously described. At some places in the old stream channels the deposits were so thick that the streams in the succeeding period of elevation and erosion found it easier to excavate new courses than to follow the old ones. Generally, however, the streams reoccupied their former channels and renewed the corrasive work which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot plain is now in many places rather uneven, yet it is more regular than the remnants of the Lafayette, Sunderland, and Wicomico plains, which have been subjected to denudation for a much longer period.

The Recent Stage.—The land probably did not long remain stationary with respect to sea level before another downward movement began. This last subsidence is probably still in progress. Before it began the Patuxent and Potomac rivers, instead of being estuaries, were undoubtedly streams of varying importance lying above tide and emptying into a diminished Chesapeake Bay. Whether this movement will continue much longer can not, of course, be determined, but with respect to Delaware River there is sufficient evidence to show that it has been in progress within very recent time and undoubtedly still continues. Many square miles that had been land before this subsidence commenced are now beneath the waters of Chesapeake Bay and its estuaries, and are receiving deposits of mud and sand from the adjoining land.

THE GEOLOGY OF PRINCE GEORGE'S COUNTY

BY

BENJAMIN L. MILLER

Introductory.

The geologic formations represented in Prince George's County range in age from Archean to Recent. Deposition, however, has not been continuous and many gaps occur, that between the Archean and Cretaceous covering a very long interval of time. None of the larger geologic divisions since Jurassic time are entirely unrepresented. Periods when there was deposition over part or the whole of the region were separated by other periods of greater or less duration in which the entire region was above water and erosion was active. The deposits of all the periods except the Archean and Pleistocene are similar in many respects. With a general northeast-southwest strike and southeast dip, each formation disappears by passing under the next later one. In general also the shore line during each successive submergence evidently lay a short distance southeast of the position

System.	Series.	Group.	Formation.
Quaternary	Pleistocene	Columbia	Talbot. Wicomico. Sunderland.
Tertiary	Pliocene (?)		Lafayette.
	Miocene	Chesapeake	Choptank. Calvert.
	Eocene	Pamunkey	Nanjemoy. Aquia.
Cretaceous	Upper Cretaceous		Monmouth. Matawan. Magothy. Raritan.
	Lower Cretaceous	Potomac	Patapsco. Arundel. Patuxent.
Archean			Granite gneiss.

it occupied during the previous submergence. There are a few exceptions to this, however, that will be noted in the descriptions which follow. The traveler passing from northwest to southeast crosses the outcrops of the formations in the order of their deposition. The general sequence is shown in the accompanying table.

The Crystalline Rocks.

The exposures of crystalline rocks within the limits of Prince George's County are confined to the deeper valleys along the northern border of the county. Elsewhere the crystallines are completely covered by the unconsolidated deposits of the Coastal Plain. Of the different varieties of rock developed in the contiguous portions of the Piedmont, only the granite gneiss and gabbro are exposed within the confines of the county. Granite gneiss, diorite, serpentine, gneisses, and schists are exposed within the District of Columbia and in near-by portions of Montgomery and Howard counties.

The oldest rock of the region is the Baltimore gneiss, or Carolina gneiss, as it was earlier named by Keith in his description of the rocks of Washington and vicinity. According to Keith—

> "The formation is composed of alternating layers of gneiss and schist of a prevailing gray color, dark bluish gray where fresh, and greenish or yellowish gray where weathered. Individual bands vary from a few inches up to several feet in thickness, with an average of perhaps less than a foot . . . . The original nature of the gneiss, whether igneous or sedimentary, is quite unknown."

GRANITE GNEISS.

The granite gneiss is the first of three classes of granite which intruded the Baltimore gneiss and one of the two crystalline types found within the limits of the county. Like the gneiss, it is almost always gray in color, and the minerals have been arranged in approximately parallel lines as a result of the metamorphism which the original granite suffered. There is, however, no true banding, as in the Baltimore gneiss, and the degree of schistosity varies from place to place. The black patches found in the granite gneiss are usually regarded as inclusions of Baltimore gneiss torn from the latter by the former at the time of intrusion.

Outside the county, within the District and elsewhere, are other granites and diorites which might be confused with the latter, al-

VIEW SHOWING SILICIFIED CYCAD TRUNK, *Cycadeoidea marylandica* (Fontaine), Cap. and Solms., FROM THE PATUXENT FORMATION OF PRINCE GEORGE'S COUNTY.

though the granites are less schistose and the diorites show hornblende more abundant than mica.

GABBRO.

Gabbro is the second type of crystalline rocks found within the county. It is exposed in the valley of the Patuxent near Laurel and has been quarried to some extent on the Howard County side, just above the Laurel bridge. When fresh and unmetamorphosed it is a dense bluish to greenish black rock of granular texture and extreme toughness. When metamorphosed it loses its granular texture, becomes more and more platy through the development of fibrous hornblende and chlorite. When the gabbro weathers it forms rounded boulders with dark rusty surfaces, well known as "nigger heads." The distribution of this type is usually marked by deep red and brown clay soils, which, though somewhat heavy, are strong and fertile.

The crystalline rocks, as a complex unit, extend southeastward beneath the Coastal Plain, and serve as the basement on which rest the gravels, sands and clays which occupy practically all of the surface of the county.

The Lower Cretaceous Formations.

THE POTOMAC GROUP.

The Potomac group of the Coastal Plain consists of highly colored gravels, sands, and clays which outcrop along a sinuous line from Pennsylvania to Richmond, passing near the cities of Philadelphia, Wilmington, Baltimore and Washington. The Potomac deposits are of great value because of the excellent brick clays which they contain. All three of the formations which are now recognized as composing this group are represented within Prince George's County.

The Patuxent Formation.

The Patuxent formation received its name from Patuxent River, in the basin of which the deposits of this horizon were first recognized as an independent formation and systematically studied. Careful work showed that the deposits formerly included in the Potomac

formation were readily separable into distinct formations on the basis of unconformities and fossil content.

Areal Distribution.—The area of outcrop of the Patuxent formation extends from the mouth of Piscataway Creek up the west shore of the Potomac River to and beyond Anacostia River which, with its tributary, Indian Creek, constitutes for the most part the eastern boundary of the formation. It underlies the greater portion of the City of Washington and extends as almost continuous outcropping beds to Laurel.

Character of Materials.—The materials composing the Patuxent formation are extremely variable, although prevailingly arenaceous. Buff and light-colored sands, both fine and coarse, predominate, while beds and lenses of clays and gravels occur less commonly. The sandy strata, which usually contain considerable amounts of kaolinized feldspar and are therefore an arkose, were called by Rogers "feldspathic sandstone." The sands are in many places cross-bedded, and with the gravels are here and there indurated by oxide of iron to form ferruginous sandstones. The sands contain small and large lenses of clay, which are commonly light in color, though locally they are highly colored by iron compounds.

The following section exposed in the northwestern part of Washington, is characteristic of the formation:

Section in northwestern part of Washington, D. C.

	Feet.
SUNDERLAND:	
Red loam	2
Stratified gravels, sands, and clays	23
PATUXENT:	
Coarse white arkosic pebbly sand, slightly lignitic; small pellets of white clay, and a lens of light greenish-drab sandy clay 5 feet in thickness. The strata show both horizontal and cross bedding. Amount exposed	15
	40

Paleontologic Character.—The organic remains of the Patuxent formation are neither plentiful nor varied. No animal remains have thus far been found in deposits of this age within Prince George's County, but a teleost fish has been reported from beds of apparently the same age on James River in Virginia. Plant remains are equally rare and consist chiefly of the lignitized and silicified trunks of

conifers and cycads. During the excavating for the new reservoir in Washington a silicified trunk 50 feet in length and several feet in diameter was found in beds belonging to the Patuxent formation. Another similar trunk about 4 feet in diameter was found in the vicinity of the Maryland Agricultural College.

Strike, Dip and Thickness.—The strike of the Patuxent formation in this county is almost due north and south along the Potomac River, but at Washington it changes to a northeast-southwest direction.

The dip of the Patuxent, as well as of the overlying beds of the Potomac group in Maryland, ranges in direction from east-southeast in its more southerly exposures to south-southeast farther north. The normal dip of the basal beds of the formation reaches about 60 feet to the mile. In the vicinity of the "Fall line," which is toward the landward margin of the Patuxent outcrop, the dip of the basal beds is considerably greater than this. Southeast of Washington it ranges from 50 to 75 feet, but near the "Fall line" it amounts to about 90 feet to the mile.

The observed thickness ranges from a few feet to 340 feet, increasing toward the east. On the basis of well data the estimated maximum thickness is about 500 feet.

Stratigraphic Relations.—The Patuxent formation overlies the granite-gneiss, of Archean age, and is overlain unconformably by the Arundel formation. In many places where the Arundel has been removed by erosion the Patuxent is overlain unconformably by clays, sands, and gravels belonging to the Columbia group.

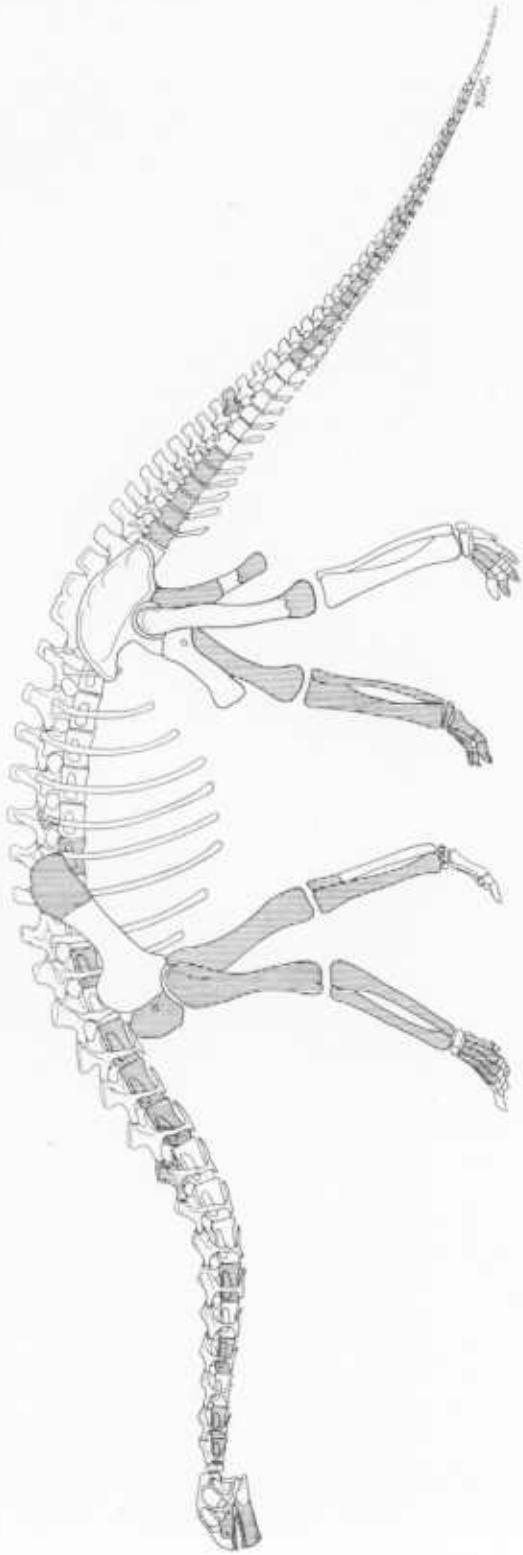
The Arundel Formation.

The Arundel formation received its name from Anne Arundel County, where the deposits of this age are typically developed and well exposed.

Areal Distribution.—The outcrops of the Arundel formation within Prince George's County are confined entirely to its northwestern portion between Washington and Laurel, but it is believed to underlie the greater portion of the county south and east of Anacostia

River. In its wider distribution the formation occupies a comparatively narrow, irregular and much interrupted belt extending from Washington to Bush River, near the head of Chesapeake Bay. There are also outliers of less importance to the north and south of the general outcrop. At Capitol Hill, Washington, a well boring, after passing through about 50 feet of Recent and Pleistocene materials, penetrated 131 feet of exceedingly tough drab and highly colored lignitic clays which apparently belong to the Arundel formation. Beneath these clays the boring passed into the Patuxent sands and gravels. Clays probably belonging to the Arundel formation were encountered in an excavation for a deep sewer in the vicinity of Anacostia bridge.

Character of Materials.—The materials composing the Arundel formation are diverse in lithologic character. They comprise large and small lenses of drab and iron-stained clays which in many places contain concretions, flakes or ledges of earthy iron carbonate and cellular limonite. Iron pyrite and gypsum occur less commonly. The clays may be either laminated, carrying more or less sand, or massive, with surfaces exhibiting slickensides. Logs of lignite, usually deposited in a horizontal position and greatly compressed, are found embedded within the formation. These logs are in places massed in well-defined beds of such thickness and extent as to be of local use to the miners for fuel. Occasionally large stumps are discovered standing buried in the position in which they grew, with the roots and trunks fossilized by iron carbonate and iron sulphide. Seeds of plants are found near some of these beds. Locally the clay is charged with comminuted lignite, when it is termed "charcoal clay" or "charcoal ore." Here and there this "charcoal clay" contains fossil bones. Near Muirkirk, Hatcher obtained from it dinosaurian and other organic remains. Where the Arundel formation has been exposed to the atmosphere the carbonate ores have at some places changed to the hydrous oxides of iron to a considerable depth. Where this has occurred, clays which were originally drab colored have become red or variegated. Along the western margin of the formation the materials become arenaceous and locally consist of lenses of sand.



RESTORATION OF THE COMMONEST CRETACEOUS DINOSAUR OF PRINCE GEORGE'S COUNTY, *Pleurocoelus nanus* Marsh. (after Lull).—1/18 NATURAL SIZE.

The section exposed at the Muirkirk iron mine, where the best dinosaurian remains thus far obtained from this formation were found, is as follows:

Section at iron mine, Muirkirk, Md.

	Feet.
RECENT:	
Surface wash, consisting of loam and gravel	10
PATAPSCO:	
Sands and gravel, indurated in places by iron oxide and containing silicified trunks of conifers and cycads	10
Massive and stratified, mottled and variegated clays and sandy clays with redeposited nodules of iron carbonate and some limonite, pebbly at base, flanking the subjacent member	5 to 15
ARUNDEL:	
Massive blue clay with flakes and nodules of iron carbonate and containing bones and teeth of dinosaurs at base	20 to 40
Highly lignitic lens of clay ("charcoal ore")	2
Tough blue clay containing iron carbonate	15
PATUXENT:	
White sand; amount exposed	10
	72 to 102

Paleontologic Character.—The fossil flora of the Arundel formation includes ferns, cycads, conifers, and possibly dicotyledons. By far the most common of these are the conifers, with whose lignitized trunks the clays are, in places, densely packed, forming local beds of lignite. Leaf impressions are also present in the iron ores.

The animal remains, while nowhere abundant, represent a variety of forms. They include worm or insect borings, pelecypods, gastropods, dinosaurs, turtles, and crocodiles. The Dinosauria, of which a number of species have been recognized, greatly predominate.

Strike, Dip, and Thickness.—The strike and dip of the Arundel formation are approximately the same as those of the Patuxent. The usual dip is 40 to 50 feet to the mile, but there is a well-marked increase near the "Fall line," where the average is about 72 feet to the mile. At Washington it is 66 feet to the mile. The maximum thickness of the Arundel is 125 feet or more and the formation thins out and disappears in some areas.

Stratigraphic Relations.—The Arundel overlies the Patuxent unconformably and is overlain unconformably by the Patapsco.

The Patapsco Formation.

The Patapsco formation received its name from Patapsco River, in whose valley it is typically exposed.

Areal Distribution.—The Patapsco has a more extended development within this county than either of the two preceding formations. Its outcrop is confined to the northwestern portion of the county, extending from Anacostia northeastward to the boundary and occurring in narrow bands near the headwaters of a few of the streams south of Anacostia. To the southeast of this outcrop it is supposed to extend over the entire county, underlying all the formations of later age. In its wider distribution the Patapsco formation has been recognized in discontinuous outcrops from the valley of Schuylkill River, near Philadelphia, to the valley of the Rappahannock, in Virginia.

Character of Materials.—The Patapsco formation is composed chiefly of highly colored and variegated clays, interbedded with sandy clays, sands, and gravels, the materials of different kinds grading into each other both horizontally and vertically. In many places the arenaceous material in the vicinity of clay beds is indurated to a conglomerate or rough, irregular, pipelike concretionary mass called "pipe ore." The variegated clays exhibit a great variety of rich and delicate tints in irregular patterns. In places they grade downward or horizontally into massive clays of chocolate, drab, and black tones, locally carrying lignite and pyrite and in some places containing iron ore and leaf impressions. The sands, which are very commonly cross-bedded, here and there carry decomposed grains of feldspar and pellets of white clay. A red ocher that is locally known as "paint rock" or "paint stone" is not uncommon, and limonite with botryoidal surfaces is found at various horizons.

Paleontologic Character.—The Patapsco formation contains a rich flora of ferns, cycads, conifers, monocotyledons, and dicotyledons. The dicotyledonous plants still constitute a minor element as compared with the other types of vegetation represented. The fauna of the Patapsco consists of a few mollusean shells and a single dino-

saurian limb bone. This latter fossil, which was found at the surface of the formation, was much worn and may have been redeposited from the Arundel.

Strike, Dip, and Thickness.—The general strike of the Patapsco corresponds practically to that of the formations which lie beneath it. The normal dip of the basal beds is southeastward at the rate of 35 to 40 feet to the mile, but the dip, like that of the preceding formations, increases toward the "Fall line."

The thickness of the Patapsco is somewhat variable, gradually increasing to the southeast. Within Prince George's County the outcropping thickness is about 100 feet. In some places, east of its outcrop, the formation is estimated to have a thickness of about 200 feet.

Stratigraphic Relations.—The Patapsco formation unconformably overlies the Patuxent or the Arundel formation of the Potomac group. It is overlain unconformably by the Raritan formation for the most part, although here and there in the region of its outcrop it is covered by Pleistocene deposits belonging to the Talbot or Wicomico formations.

The Upper Cretaceous Formations.

The Raritan Formation.

The formation receives its name from Raritan River, New Jersey, in the basin of which it is typically developed. It includes the deposits long called the Plastic or Amboy clays by the New Jersey Geological Survey. On the basis of the plant fossils, the formation has been regarded as representing the Cenomanian series of European geologists.

Areal Distribution.—In its wider distribution the Raritan formation has been recognized from Raritan Bay, New Jersey, to the basin of Potomac River. In the northwestern portion of the county it is represented by a narrow outcrop which crosses the area in a sinuous line from northeast to southwest and is also present near the headwaters of some of the creeks along the western margin of the county.

It dips under the overlying strata and is believed to extend over the entire central and eastern area of the county beneath the younger formations.

Character of Materials.—The Raritan consists of variable materials similar to those composing the Patapsco formation except that, in general, the clays are not so highly colored. White and buff sands; stratified sandy clays, light chocolate in color, in places containing leaf impressions; light-colored argillaceous sands and sandy clays ("fuller's earth"); and white, yellow, drab, bluish drab, and variegated clays all occur in deposits of this age. The drab clays are here and there lignitic and pyritiferous, and in places exhibit partings of sand indurated with mammillary limonite. Ledges of sandstone, indurated by iron oxide or silica, are common. One and one-quarter miles north of Collington white quartzitic sandstones represent this phase. Several acres are covered with these masses of hard rock, which have been used for structural purposes in the vicinity. Similar sandstones of Raritan age occur in several places in Anne Arundel and Baltimore counties. The light-colored sands show in many localities large blotches of red ocher, locally designated as "paint pots." The Raritan deposits can not everywhere be separated with ease from the underlying Patapsco strata, but there is much less difficulty in separating them from those of the overlying Magothy formation, which are much more uniform in character and less highly colored.

Paleontologic Character.—Both animal and plant remains have been found in the Raritan formation, but the known fauna is very scanty both in individuals and species, the flora being much more abundant. Logs of lignitized conifers exhibiting teredo borings have occasionally been found, and in New Jersey this formation has yielded some bones of a plesiosaur and various molluscan remains. No dinosaurian remains have thus far been found in Raritan strata.

The flora of the formation includes ferns, fronds of cycads, conifers, monocotyledons, and dicotyledons, the last-named being particularly conspicuous and relatively modern in aspect. The Raritan

has yielded no silicified trunks of cycads, so far as is definitely known.

Strike, Dip, and Thickness.—The strike and dip of the Raritan formation correspond closely with those of the Patapsco. The normal dip of the basal beds is about 30 feet to the mile, but this increases toward the "Fall line." Within this area of outcrop in Prince George's County the Raritan formation is relatively thin in comparison with its thickness farther northeast. The estimated maximum thickness toward the extreme eastern margin of the belt of outcrop in this county is about 100 feet. The thickness of the formation seems to increase toward the southeast beyond the line where it disappears beneath later deposits.

Stratigraphic Relations.—The Raritan unconformably overlies the Patapsco formation, and is separated from the overlying Magothy by another marked unconformity. In the region of its outcrop, Pleistocene deposits of the Talbot, Wicomico, and Sunderland formations overlie the edges of the Raritan and generally conceal the deposits from view except where erosion has removed these later beds.

The Magothy Formation.

The Magothy formation takes its name from the excellent exposures of the beds of this age along the Magothy River in Anne Arundel County and was characterized by Darton[1] in 1893. Later work in Maryland seemed to indicate that these deposits represented merely phases of deposition within the Raritan. On this supposition, the fossil plants found in them were supposed to be Raritan forms and the stratigraphic break was attributed to contemporaneous erosion. In New Jersey the Magothy deposits in the vicinity of Philadelphia were placed in the Raritan, while those in the region of Raritan Bay, under the name Cliffwood beds, were by some geologists included in the Matawan on account of the presence of glauconite and the great percentage of post-Raritan plants and marine invertebrates, and by others were placed in the Raritan. Recent studies of the fossils and careful stratigraphic work in the

[1]Darton, Amer. Jour. Sci., 3d ser., vol. XLV, 1893, pp. 407-419.

field, however, have shown that the Magothy should be regarded as a distinct formation, on both stratigraphic and paleontologic grounds, and these transitional beds from New Jersey southward have been referred by Clark[2] to the Magothy formation as defined by Darton for the Maryland area.

Areal Distribution.—The Magothy formation outcrops in discontinuous areas in Prince George's County, extending from the Patuxent River valley in the vicinity of Priest Bridge southwestward to the Potomac River valley just beyond Congress Heights. It does not outcrop in a continuous belt because of an overlap of the Matawan, which is in some places sufficient to bring that formation in immediate contact with the Raritan. An occurrence of this kind can be seen about three-fourths of a mile west of Brightseat. The best exposures lie from half a mile to 3 miles west of Priest Bridge and along the west slope of Good Hope Hill from St. Elizabeth's to the junction of Benning and Bowen roads on the District line.

Character of Materials.—The Magothy formation is composed of extremely varied materials and may change abruptly in character both horizontally and vertically. Loose sands of light color are the most prominent constituents. These sands usually show fine laminations and locally considerable cross-bedding. The sand consists of coarse, rounded to subangular quartz grains which range in color from pure white to a dark ferruginous brown. At many places lenses or bands of brown sand occur within the lighter colored sands. Normally the deposits of sand are loose, yet locally the iron derived from this and adjacent formations has firmly cemented the grains together to form an indurated iron sandstone or conglomerate. A thin ledge of such a sandstone near the Catholic Church west of Priest Bridge forms a small waterfall in a tributary of Patuxent River. Just below Overlook Inn, on East Washington Heights, there is a ledge of massive brown sandstone of this character.

The argillaceous character of the Magothy is very prominent in some localities, although it is usually subsidiary to the arenaceous phase. The clay commonly occurs as fine laminæ alternating with

[2]Clark, Amer. Jour. Sci., 4th ser., vol. XVIII, 1904, pp. 435-440.

the sand layers. Drab is the eharaeteristic color of the Magothy elay, but here and there the presenee of eonsiderable vegetable remains renders it black. The vegetable material may be finely divided or may oeeur in the form of large pieees of lignite. Thus far no bright-eolored elays have been recognized in the Magothy deposits.

The Magothy ean usually be differentiated from the underlying Raritan formation by its laek of massive beds of brightly colored variegated clay, and by the greater variability in the eharacter of its materials. It ean be more easily distinguished from the overlying Matawan by the almost eomplete absence of glaueonite (although small pockets of greensand have been found in the Magothy at a few localities), by its lack of homogeneity, and by its variations in color. Moreover, the Matawan in Maryland usually contains considerable amounts of mica in small flakes, whereas the Magothy contains little mica.

Paleontologic Character.—In this county the only organic remains thus far reeognized in the Magothy are leaf impressions in the drab clays that occur in thin laminæ alternating with layers of sand. Berry[1] has recorded *Widdringtonites Reichii* from the Overlook Inn Road on Congress Heights, and large collections from near Brightseat and Pennsylvania Avenue extended are being studied at the present time. At Cliffwood Bluff, on the south shore of Raritan Bay, New Jersey, beds of this formation have yielded a considerable flora and a marine fauna. The flora studied by Berry[1] is notably varied, over 100 species having been described. The flora presents many points of similarity to that of the Raritan, yet it contains many new species of forms characteristic of post Raritan formations in other regions. The most common fossil plant of that locality is represented by the imperfectly petrified cones of *Sequoia gracillima.* Other common species are *Cunninghamites squamosus, Dammara cliffwoodensis,* and *Sequoia reichenbachi.* Berry and Hollick

[1]Bull. Torrey Club, vol. XXXIII, 1906, p. 169.

[1]Bull. New York Bot. Gard., vol III, No. 9, 1903, pp. 45-103; Bull. Torr. Bot. Club, vol. XXXI, 1904, pp. 67-82; vol. XXXII, pp. 43-48; Ann. Rept. State Geol. New Jersey for 1905, pp. 135-172.

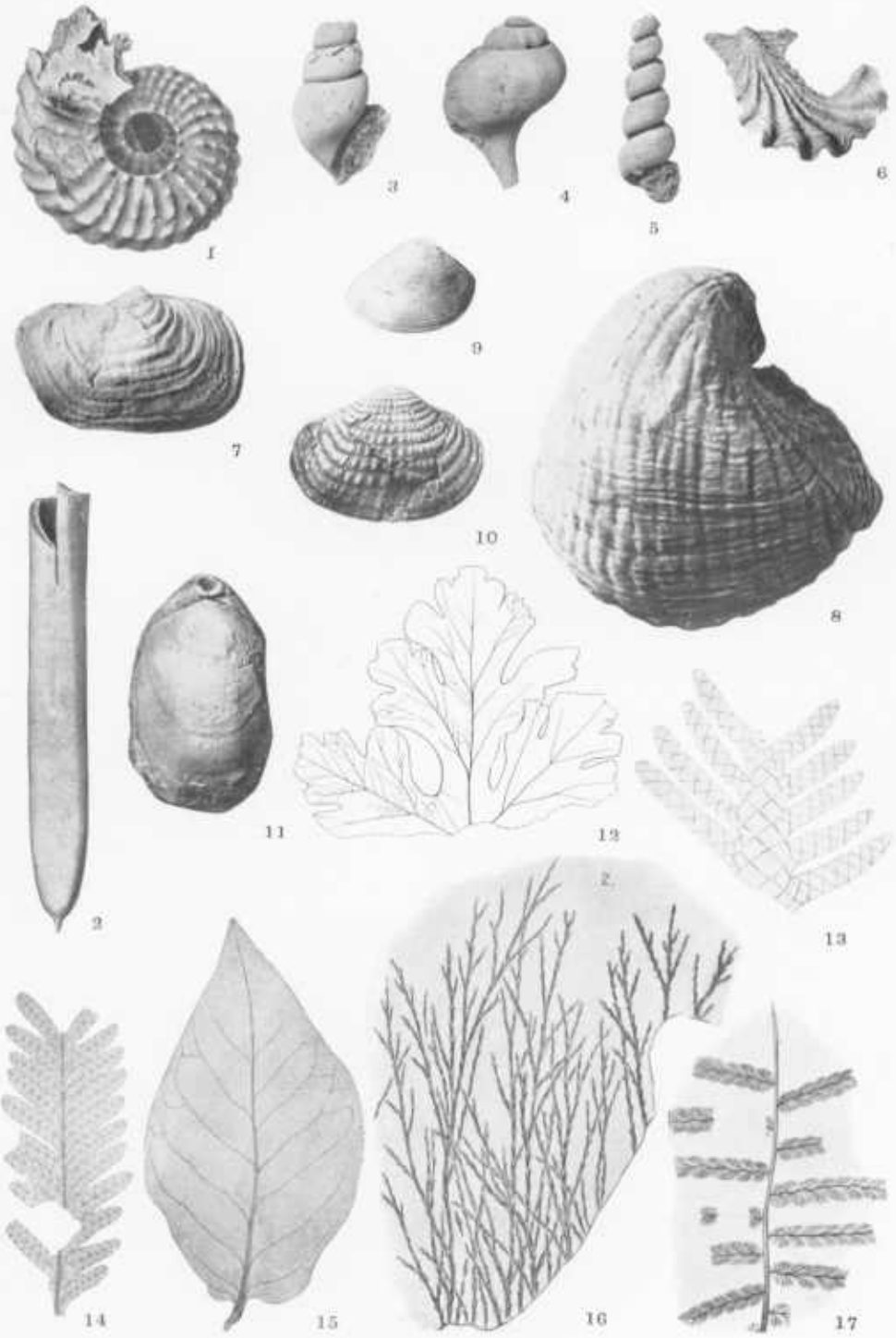
state that the flora of the "Cliffwood beds" shows Cenomanian characteristics.

The animal remains described by Weller[2] from the Magothy at Cliffwood Point were found in smooth concretionary nodules in a clay bed or lying loose on the beach, where they were left by the erosion of the clay beds that originally contained them. The fauna is characterized by the presence of great numbers of crustacean remains. Some portion of a crab seems to have been the nucleus about which the nodules were formed in almost every instance. Pelecypods, gasteropods, and cephalopods also occur. The most abundant forms are the following pelecypods: *Trigonarca* sp., *Pteria petrosa, Nuculana protexta (?), Yoldia evansi, Isocardia cliffwoodensis, Veleda lintea, Corbula* sp., and among the Crustacea *Tetracarcinus subquadratus.* These are of considerable importance, for, with the exception of a few forms from the Raritan in the same area, they are the earliest marine fossils found in the deposits of the Atlantic Coastal Plain. Weller states that the assemblage of forms constitutes a distinct faunule which more nearly resembles the faunule of the Matawan formation than any other.

Strike, Dip, and Thickness.—The strike of the Magothy formation is roughly parallel to that of the other Coastal Plain formations—from northeast to southwest. The dip is southeastward, at about 30 to 35 feet to the mile. Within Prince George's County the maximum thickness of the Magothy formation is about 40 feet, but in its wider extent the thickness is extremely variable, reaching a maximum of about 100 feet. This variability is due to greater deposition in some regions than in others and also to the removal of considerable Magothy material in certain areas.

Stratigraphic Relations.—The Magothy formation lies between the Raritan and Matawan formations and is separated from each by an unconformity. The line of contact between the Magothy and the Raritan is very irregular, indicating a considerable erosion interval between the times of their deposition. In many places the Magothy deposits fill pockets and old channels in the Raritan. The uncon-

[2]Ann. Rept. State Geol. New Jersey for 1904, pp. 133-144.



VIEWS SHOWING CHARACTERISTIC UPPER CRETACEOUS FOSSILS OF PRINCE GEORGE'S COUNTY.

FIG. 1.—AMMONITES (Morloniceras) VANUXEMI Morton.
FIG. 2.—BELEMNITELLA AMERICANA (Morton).
FIG. 3.—ANCHURA PENNATA (Morton).
FIG. 4.—TURBINELLA ALABAMENSIS (Gabb).
FIG. 5.—TURRITELLA VERTEBROIDES Morton.
FIG. 6.—OSTREA FALCATA Morton.
FIG. 7.—PANOPEA DECISA Conrad.
FIG. 8.—ENOGYRA COSTATA Say.
FIG. 9.—NUCULA PERCRASSA Conrad.
FIG. 10.—CYMELLA BELLA Conrad.
FIG. 11.—TEREBRATULA HARLANI Morton.
FIG. 12.—CISSITES PARVIFOLIUS Berry.
FIG. 13.—BRACHYPHYLLUM MACROCARPUM Newberry.
FIG. 14.—MORICONIA AMERICANA Berry.
FIG. 15.—MAGNOLIA HOLLICKI Berry.
FIG. 16.—WIDDRINGTONITES REICHII (Ettings.) Heer.
FIG. 17.—OSMUNDA DELAWARENSIS Berry.

formity between the Magothy and the Matawan is not so plainly marked; at many places these beds seem to be conformable. Indications of an erosion interval may be seen in some good exposures, however, and in the area of this county between Patuxent and Potomac rivers there is a marked unconformity of overlap. A short distance northeast of the District of Columbia line the Magothy is entirely lacking, its absence being due to an overlap of the Matawan, which rests upon the Raritan. Farther south it again makes its appearance. In the region of its outcrop the formation is in many places overlain by Pleistocene deposits.

The Matawan Formation.

The formation has received its name from Matawan Creek, a tributary of Raritan Bay, New Jersey, in the vicinity of which the deposits of this horizon are extensively and typically developed. The name was proposed by W. B. Clark[1] in 1894 and replaced the term Clay marls, previously used by the New Jersey geologists. The fossils of the Matawan formation furnish evidence of its Upper Cretaceous age.

Areal Distribution.—In Prince George's County the Matawan formation is found in a sinuous line extending from the Patuxent River valley near Priest Bridge southwestward to Fort Washington. Throughout this area it is exposed along the margins of the streams, but is covered by younger materials as it passes under the divides. The Matawan resembles the other Cretaceous formations in having a dip to the southeast which carries it beneath later deposits. It undoubtedly underlies the entire county to the southeast of the line of outcrop. In its broader distribution through the Coastal Plain, the Matawan formation extends as a continuous series of outcropping deposits from Raritan Bay to Potomac River.

Character of Materials.—The Matawan consists chiefly of glauconitic sand intimately mixed with dark-colored clay, while all through the material small flakes of mica are commonly found. In some places the deposits consist almost entirely of black clay; in

[1]Clark, Jour. Geol., vol. II, 1894, pp. 161-177.

others, particularly where the upper beds are exposed, the arenaceous phase is predominant and the beds may consist entirely of sands varying in color from white to dark-greenish black. Where the glauconite decomposes, the iron oxidizes and the materials are stained reddish brown, and may even become firmly indurated by the iron oxide. Iron pyrite is also a common constituent and in places a small layer of gravel lies at the base of the formation. Although the Matawan contains varied materials it is much less variable than formations of the Potomac group or the Magothy formation, and throughout its extent in Maryland can generally be readily recognized by the prevailing dark-colored micaceous glauconitic sand of which it is chiefly composed.

Paleontologic Character.—Although the Matawan formation as a whole can not be regarded as extremely fossiliferous, yet it contains bands in which organic remains are present in great abundance. Such a band occurs in the cutting where the Chesapeake Beach Railway crosses Central avenue just east of the District line. In New Jersey as well as in Maryland the formation has yielded a varied fauna of foraminifers, pelecypods, gastropods, scaphopods, and ammonites.[1]

Strike, Dip, and Thickness.—The formation strikes from northeast to southwest and dips southeastward at about 25 feet to the mile. The maximum thickness of the Matawan occurs in the Patuxent River valley and is about 40 feet. From this region the formation gradually thins toward the southwest until it is not more than 30 feet thick in the exposures along Henson Creek and about 20 feet thick in the Fort Washington hill. Like many other Coastal Plain formations, the beds thicken as they dip beneath later deposits, but the records of wells which have penetrated these formations in the eastern part of the county are too general to permit the determination of the amount of thickening.

Stratigraphic Relations.—In places a marked unconformity separates the Matawan from the underlying Magothy formation, but it is conformably overlain by the Monmouth. The separation between

[1]Clark, Bull. Geol. Soc. America, vol. VIII, 1897, pp. 330-331.

the Matawan and Monmouth is made chiefly on the basis of change in lithologic character, but in part on that of the fossil contents. Although some organic forms range through both the Matawan and Monmouth, yet each formation has a few characteristic forms, the assemblage in each being on the whole fairly distinctive.

The Monmouth Formation.

The name Monmouth was first proposed for this formation in 1897 by W. B. Clark[1] when it was decided to combine in a single unit the deposits formerly included in the Navesink and Redbank formations. It was suggested by Monmouth County, New Jersey, where the deposits of this horizon are characteristically developed, and replaces the term Lower Marl bed of the earlier workers in New Jersey. On the basis of its marine fauna it is correlated with the Senonian of Europe.

Areal Distribution.—Within this county the Monmouth formation has only a slight development. It outcrops in the vicinity of Collington and eastward from that place to Patuxent River and thence southward along the banks of the stream to the vicinity of Governor Bridge. The Monmouth dips to the southeast and is believed to underlie the Eocene and Miocene deposits to the southeast of its outcrop. In its wider distribution the formation has been recognized by outcrops in a zone extending from the northeastern portion of this county to Raritan Bay in New Jersey.

Character of Materials.—The formation is prevailingly arenaceous in character and unconsolidated except where locally indurated by the segregation of ferruginous material derived from the glauconite. The sands composing the Monmouth deposits vary in color from reddish brown to dark green or nearly black. The fresh material always contains considerable glauconite and this gives to the deposits their dark color. In their more weathered portions the sands generally range in color from rich brown to reddish brown, but at some places they are dark gray.

[1]Clark, Bull. Geol. Soc. Amer., vol. VIII, 1897, pp. 315-358.

Paleontologic Character.—The Monmouth formation is generally very fossiliferous and the forms are usually well preserved. They consist of foraminifers, pelecypods, gastropods, and cephalopods. Among the most abundant are *Exogyra costata* Say, *Gryphaea vesicularis* Lamarck, *Idoncarca vulgaris* Morton, *Cardium perelongatum* Whitney, and *Belemnitella americana* Morton. They are typical Upper Cretaceous species.

Strike, Dip and Thickness.—The strike of the Monmouth formation is from northeast to southwest, and the dip is toward the southeast at the rate of about 25 feet to the mile. The maximum thickness of the Monmouth formation along its outcrop in the area of Prince George's County is from 40 to 50 feet. In northern New Jersey it is about 200 feet thick, but it steadily decreases in thickness along the strike southwestward, until it finally disappears as an outcropping formation in the north-central part of this county.

Stratigraphic Relations.—The Monmouth is conformable with the underlying Matawan and with the Raritan, which overlies it on the Eastern Shore of Maryland and in Delaware and New Jersey. Within Prince George's County it is overlain unconformably by Eocene and Pleistocene deposits. The Monmouth is readily distinguished from the Matawan, as it lacks the darker colored micaceous sands and marls of that formation. From the Raritan it is distinguished by the great predominance of reddish-brown sand.

The Eocene Formations.

THE PAMUNKEY GROUP.

The Aquia Formation.

The formation receives its name from Aquia Creek, a tributary of Potomac River in Virginia, where deposits belonging to this horizon are characteristically developed. This name was proposed by W. B. Clark[1] in 1895.

[1]Clark, Johns Hopkins Univ. Circ., 1895, p. 3.

FIG. 1.—VIEW SHOWING IRREGULAR NODULES IN THE MATAWAN FORMATION NEAR PRIEST BRIDGE.

FIG. 2.—VIEW SHOWING CONTACT BETWEEN AQUIA GREENSAND AND NANJEMOY PINK CLAY AT UPPER MARLBORO.

Areal Distribution.—The Aquia is exposed throughout a broad belt 10 miles or more in width, extending from the vicinity of Collington southwestward as far as Western Branch of Patuxent River. Beyond the latter point the formation is buried beneath later deposits and outcrops only in a thin band near the headwaters of the creeks along the western margin of the county and along the Potomac River at Fort Washington. The Aquia formation dips to the southeast and is supposed to underlie the younger Eocene and Miocene beds throughout the southern portion of the area. In its wider distribution it extends from Virginia northeastward across Maryland to Delaware.

Character of Materials.—This formation consists usually of loose sand in which there is a considerable admixture of glauconite, the latter in places making up the body of the formation. Where the material is fresh it ranges in color from a light blue to a very dark green, but in regions where it has been exposed to weathering for a considerable time it has assumed a reddish-brown to light-gray color. The beds are in most places unconsolidated, although locally some have become very firmly indurated by oxide of iron. Small, well-rounded pebbles coated with iron oxide occur in a few places near the base of the formation. These gravels are typically exposed about a mile northwest of Westphalia and in numerous places about Collington. About half a mile southwest of Collington this pebble layer, which is about 2 feet in thickness, has been cemented by ferruginous material into a hard, compact rock that has been used for building purposes. Where the Aquia deposits have been exposed to the action of the atmosphere, as on the tops of divides, the iron present in the glauconite has been segregated to form bands of iron sandstone. These are very numerous and in places attain a thickness of 1 to 2 feet. Near Upper Marlboro there are a few ledges of indurated marl from which numerous species of fossils have been obtained.

This is one of the longest and best known localities for fossils in the Eocene of the Atlantic slope. The following section is exposed:

Section east of bridge at Upper Marlboro, Md.

	Feet.
NANJEMOY:	
Glauconitic clay	22
Pink clay, without glauconitic or fossils	22
AQUIA (Paspotansa substage):	
Coarse glauconitic sand	32
Shell marl with *Gibbula glandula, Fissuridea marlboroensis, Lucina aquiana, Diplodonta marlboroensis, Venericardia planicosta* var. *regia, Pteria limula, Cucullaea gigantea, Leda parilis, Nucula ovula*	2
Indurated ledge with *Turritella mortoni, T. humerosa, Mesalia obruta, Calyptraphorus jacksoni, Panopea elongata, Meretrix ovata* var. *pyga, Dosiniopsis lenticularis, Venericardia planicosta* var. *regia, Crassatellites alaeformis, Astarte marylandica, Glycymeris idoneus, Cucullaea gigantea, Leda parilis, Nucula ovula*	5
Glauconitic sand (known as Bryozoan sand) full of fine fragments of shells accompanied by Bryozoa, echinoid spines, and Foraminifera; and with *Ostrea compressirostra, Gryphaeostrea vomer,* and *Platidia marylandica*	5
	88

Paleontologic Character.—A great many fossils are to be seen in the outcrops of the Aquia along the Patuxent River and in the valley of Piscataway Creek. An idea of the variety of fossils that occur in these localities may be gained by consulting the section above. The fossils of this formation have been described and illustrated in the report on the Eocene issued by the Maryland Geological Survey.

Strike, Dip, and Thickness.—The Aquia formation is about 100 feet thick in this county and gradually thickens toward the east, beneath the later formations. It has a northeast-southwest strike and dips to the southeast at the rate of about 12½ feet to the mile.

Stratigraphic Relations.—The Aquia formation overlies the Monmouth unconformably and is overlain conformably by the Nanjemoy formation. Where the Nanjemoy has been removed by erosion it is covered by Miocene, Lafayette, or Pleistocene beds.

Subdivisions.—The Aquia formation has been subdivided into two members or substages known as Piscataway and Paspotansa, which are distinguished from each other by their contained fossils.

The Piscataway member was named from Piscataway Creek, Maryland, where it is typically developed. The member is characterized by two well-marked and rather persistent layers of indurated marls. Its thickness somewhat exceeds 50 feet. It is further characterized by a fossil fauna among which are the following forms:

Thecachampsa sericodon (?) Cope.
Synechodus clarkii Eastman.
Odontaspis elegans (Agassiz).
Otodus obliquus (Agassiz).
Pholadomya maryiandica Conrad.
Gryphæa vesicularis Lamarck.
Textularia subangulata D'Orbigny.

The Paspotansa member was named from Paspotansa Creek, Virginia. It consists of a bed of greensand and greensand marl somewhat less than 50 feet thick. Among the characteristic fossils of this member are the following:

Bythocypris subæquata Ulrich.
Pleurotoma harrisi Clark.
Cancellaria graciloides Aldrich var.
Trophon sublevis Harris.
Chrysodomus engonatus (Heilprin).
Calyptraphorus jacksoni Clark.
Discosparsa varians Ulrich.
Membranipora angusta Ulrich.
Textularia gramen D'Orbigny.
Anomalina ammonoides (Reuss).

The Nanjemoy Formation.

The formation receives its name from Nanjemoy Creek, one of the tributaries of Potomac River in Maryland, in whose valley deposits belonging to this horizon are characteristically developed. This name was proposed by Clark and Martin in 1901.[1]

Areal Distribution.—The Nanjemoy formation is much less extensively exposed in this county than the Aquia. It extends across the county from Hardesty to the valley of Piscataway Creek in a very circuitous and broken outcrop. In its larger relations it extends from Virginia northwestward through Maryland as far as Chesa-

[1]Eocene, Maryland Geol. Survey, p. 64.

peake Bay. On the Eastern Shore it does not outcrop and is so deeply buried by later deposits that it has not yet been recognized with certainty in well borings.

Character of Materials.—The Nanjemoy formation consists primarily of greensand, which is in most places highly argillaceous and locally calcareous, with certain layers carrying abundant crystals and crystalline masses of gypsum. The formation contains considerable clay, especially at its base, as shown in the section at Upper Marlboro already given. The following section is fairly typical and characteristic of the glauconite phase:

Section in ravine 1 mile south of Thrift, Md.

	Ft.	In.
MIOCENE:		
Lead-colored clay with Miocene fossils	40	0
EOCENE (Nanjemoy-Potapaco substage):		
Dark argillaceous greensand	7	0
Argillaceous greensand, packed with *Venericardia potapacoenis*	1	0
Dark glauconitic clay	3	0
Layer of *Venericardia potapacoenis*	0	8
Greensand with many scattered specimens of *Venericardia potapacocnis*	3	0
Line of concretions	0	6
Glauconitic clay with *Venericardia potapacoenis*	4	0
Dark greensand	5	0
Layer packed with shells of *Venericardia potapacoenis.*	1	6
Argillaceous greensand	1	0
Line of concretions	0	6
Argillaceous greensand	3	0
Greensand with *Venericardia potapacocnis*	1	0
Dark glauconitic clay	3	0
Layer of shells of *Venericardia potapacoenis*	0	4
	74	6

Paleontologic Character.—A great many fossils are to be seen in the outcrops of the Nanjemoy formation along South and Patuxent rivers, along Piscataway, Mattawoman, and Nanjemoy creeks in Maryland, and along Potomac and Aquia creeks in Virginia. An idea of the abundance of these fossils may be obtained by examining the foregoing section. The fossils of the Nanjemoy formation have been described and illustrated in the report on the Eocene issued by the Maryland Geological Survey.

VIEWS SHOWING CHARACTERISTIC FOSSILS OF THE EOCENE OF PRINCE GEORGE'S COUNTY.

FIG. 1.—TURBINOLIA ACUTICOSTATA Vaughan.
FIG. 2.—CARPOLITHES MARYLANDICUS Hollick.
FIG. 3.—MERETRIX OVATA VAR PYGA Conrad.
FIG. 4.—MODIOLUS ALABAMENSIS Aldrich.
FIG. 5.—OSTREA COMPRESSIROSTRA Say.
FIG. 6.—GLOBIGERINA BULLOIDES d'Orb. (Greatly enlarged).
FIGS. 7, 8.—CRASSATELLITES ALAEFORMIS (Conrad).
FIG. 9.—STREPSIDURA SUBSCALARINA Heilprin.
FIG. 10.—CALYPTRAPHORUS TRINODIFERUS Conrad var.
FIG. 11.—CORBULA ALDRICHI Meyer.
FIG. 12.—VENERICARDIA PLANICOSTA VAR REGIA Conrad.
FIG. 13.—PLEUROTOMA TYSONI Clark and Martin.
FIG. 14.—DOSINIOPSIS LENTICULARIS (Rogers).
FIG. 15.—CUCULLAEA GIGANTEA Conrad.
FIG. 16.—TURRITELLA MORTONI Conrad.

Strike, Dip, and Thickness.—The formation has a northeast-southwest strike and dips toward the southeast at an average rate of about 12½ feet to the mile. The Nanjemoy is about 100 feet thick in Prince George's County and thickens gradually toward the east.

Stratigraphic Relations.—The Nanjemoy overlies the Aquia conformably, but is overlain unconformably by the Miocene, and in some places along the line of outcrop by deposits belonging to the Lafayette and the Pleistocene.

Subdivisions.—This formation, like the Aquia, is subdivided into two members or substages, known as the Potapaco and Woodstock.

The Potapaco member is so called from the early name of Port Tobacco (a corruption of the word Potapaco) Creek, one of the Maryland tributaries to Potomac River. It is characteristically clayey, especially in its lower portions. It is about 60 to 65 feet thick and carries the following characteristic fossils:

Cypræa smithi Aldrich.
Solen lisbonensis Aldrich.
(?) Lucina astartiformis Aldrich.
Ceiropora micropora Goldfuss.

This member is further subdivided into six zones which, together with their characteristic fossils, are fully discussed by Clark and Martin in the report already cited.[1]

The Woodstock member has been named from Woodstock, an old estate situated a short distance from Mathias Point on the Virginia side of the Potomac. This member is characterized by fine homogeneous greensands and greensand marls which are less argillaceous than the underlying Potapaco beds. It ranges in thickness from 60 to 65 feet and contains certain characteristic fossils, a few of which are the following:

Pyrula penita Conrad var.
Meretrix lenis (Conrad).
Leda parva (Rogers).
Spiroplecta clarki Bagg.
Nonionina affinis Reuss.

[1]Eocene, Maryland Geol. Survey, 1901, pp. 65-66.

The Woodstock member is further subdivided into two zones distinguished by characteristic fossils. These zones are described in the above-mentioned report on the Maryland Eocene, which also contains a full list of the fossils which characterize the member.

The Miocene Formations.

THE CHESAPEAKE GROUP.

The Calvert Formation.

This formation receives its name from Calvert County, Md., where, in the well-known Calvert Cliffs bordering Chesapeake Bay, its typical characters are well shown.

Areal Distribution.—The Calvert is by far the most extensive formation in Prince George's County. Although it is largely covered with Lafayette and Columbia gravels, yet stream erosion has cut down to it in so many places that its distribution is very well known. It outcrops in nearly every stream-cutting throughout the southern half of the county and is represented by outliers well up on the divides over a large portion of the northern half. In its larger distribution it extends from Virginia northeastward across Maryland and Delaware into New Jersey. It has by far the most extensive development of all of the Cretaceous and Tertiary formations in this region.

Character of Materials.—The materials constituting the Calvert formation consist of blue, drab, and yellow clay, yellow to gray sand, gray to white diatomaceous earth, and calcareous marl. Between these all gradations exist. The diatomaceous earth gradually passes into fine sand by the increase of arenaceous material, or into a clay by the addition of argillaceous matter. In a similar way a sand deposit with little or no clay grades over into a deposit of clay in which the presence of sand can not be detected. Notwithstanding this variety of materials a certain sequence of deposits is commonly observed; the basal portions of the formation consist largely of diatomaceous earth, while the upper portions are composed chiefly of sand, clays, and marls. This difference in materials has led to

a subdivision of the formation into two members, which are described below.

In a great many places, the Calvert is separated from the Eocene by a siliceous sandstone 6 to 12 inches in thickness. This ledge itself has been found to contain Miocene fossils and in places it is separated from the Eocene greensand by as much as a foot of loose sand. In Prince George's County this ledge is exposed in many places in the southeastern portion of the County, and is everywhere distinguishable from any other material present in the Miocene or Eocene. One of the best exposures of it is about 2½ miles northwest of Nottingham along Mataponi Creek, where the following section has been taken.

Section along Mataponi Creek.

	Ft.	In.
CALVERT:		
Diatomaceous earth, gray in color, mixed with considerable sand in the lower portion but passing upward into a very pure variety	20	0
Siliceous ledge with sand grains visible on roughened weathered surface but indistinguishable in interior; vitreous cleavage; outside gray, interior black	0	6
Iron-stained sand with a considerable admixture of clay, arranged in thin layers suggesting shales	0	10
NANJEMOY:		
Coarse glauconitic sand, dark at base becoming lighter in color and more micaceous near Miocene contact. Exposed	6	0
	27	4

Paleontologic Character.—The diatomaceous earth and the dark-colored clays represented in the Calvert of this county contain abundant casts of marine mollusks, almost invariably of small size. These beds also contain leaf remains.

Strike, Dip, and Thickness.—The strike of the Calvert formation is from northeast to southwest, and it dips toward the southeast at the rate of about 11 feet to the mile. The full thickness of the Calvert formation has been nowhere actually observed along the line of outcrop. The formation has been diagonally truncated by the Choptank, so that in this region it shows a maximum thickness of only about 100 feet. The Choptank and younger formations lie

above it unconformably. Fortunately, a reliable well record at Crisfield, Somerset County, exhibits the entire thickness of Miocene strata. In this well the Calvert formation is apparently about 300 feet thick. As this well is located in the extreme southern portion of the State and far down the dip, there is probably a rapid thickening of this formation as it passes to the southeast toward the ocean. At Chesapeake Beach, on the bay shore in Calvert County, a well which begins in the Calvert formation a little above tide passes out of it and into the Eocene at a depth of 60 feet; at Centerville it is found at a depth of 81 feet and is 65 feet thick; at Crisfield the formation lies 465 feet below the surface.

Stratigraphic Relations.—Near the Maryland-Delaware border the Calvert rests unconformably upon one of the Cretaceous formations (Rancocas). Farther southwest it overlies the Aquia formation, and in southern Maryland it lies unconformably upon the Nanjemoy, a relationship which shows the gradual transgression of the Miocene deposits southwestward. In this county it lies unconformably upon the Nanjemoy, Aquia, or Matawan formations and is overlain unconformably by deposits belonging to the Lafayette or Pleistocene.

Subdivisions.—The Calvert formation has been divided into two members, known as the Fairhaven diatomaceous earth and the Plum Point marls. These are more fully described in the above-mentioned report on the Miocene of Maryland.

The Fairhaven diatomaceous earth lies at the base of the formation and is characterized by the presence of a large proportion of diatoms embedded in a very finely divided quartz matrix. Calcareous material is present in this bed in only very small amounts. Besides diatoms, there are other Miocene fossils, usually in the form of casts, and organic remains reworked from the underlying Eocene beds. The name for this member is derived from Fairhaven, Anne Arundel County, where the beds are well developed.

The contact of the diatomaceous earth with the Eocene beds lies about 2 feet beneath a band of sandstone from 4 to 8 inches thick,

which carries casts of *Pecten humphreysii* and other Miocene fossils. Above this sandstone is the diatomaceous earth proper. This bed, which is about 20 feet thick, is greenish blue when fresh, but weathers to a brown or a light-buff to white color on long exposure to the atmosphere. In the extensive pits at Lyons Creek wharf in Calvert County, just across the river from this county, where the material is worked commercially, the transition from greenish blue to buff is very conspicuous.

From Fairhaven the diatomaceous beds cross southern Maryland in a northeast-southwest direction, following the line of strike, and are worked at Lyons Creek on the Patuxent, and at Popes Creek on the Potomac in Charles County. They may also be found at numerous places between these points, in cuts made by waterways. Southeast of this diagonal line they gradually disappear below tide. The Fairhaven diatomaceous earth is further subdivided into three zones that are recognized by the materials and fossils which they contain.

The Plum Point marls constitute the remainder of the Calvert formation above the Fairhaven diatomaceous earth. At Plum Point, Calvert County, the beds are typically developed, and this fact has suggested the name of this member. It consists of a series of sandy clays and marls in which are embedded large numbers of organic remains, including diatoms. The color of the material is bluish green to grayish brown and buff. Fossil remains, although abundant through the entire member, are particularly numerous in two prominent beds, from 30 to 35 feet apart, in the Calvert Cliffs. These marls vary in thickness from 4½ to 13 feet. Along Patuxent River the Plum Point marls are not exposed so extensively as in the Calvert Cliffs, but they are visible at intervals from the cliffs below Lower Marlboro southward to Ben Creek, in Calvert County. On the west bank of the river they may be seen here and there from a point opposite Lower Marlboro downstream to a point 1½ miles below Forest Wharf, in St. Mary's County.

Along the Potomac River, the banks are usually very low and composed of Columbia sand and gravel. In consequence of this the Plum Point marls are exposed at but few places. On the Maryland side of the river they may be seen in the low cliffs at the mouth of

Chaptico Bay, in St. Mary's County, and on the Virginia side a considerable thickness of the marls is exposed along the entire length of the Nomini Cliffs. When fresh, the Plum Point marls and the Fairhaven diatomaceous earth do not differ much in appearance. The thickness of the marls increases constantly down the dip. This member is subdivided into 12 zones, which are distinguished by the lithologic character of the materials and by characteristic fossils.

The Choptank Formation.

This formation receives its name from Choptank River, Maryland, because of its great development on the northern bank of that estuary a short distance below Dover Bridge.

Areal Distribution.—The Choptank formation is confined to the southeastern portion of Prince George's County. It is exposed in the headwaters of the minor streams in the vicinity of Orme and Aquasco. In Calvert County it may be found in a long line of outcrops extending from the hilltops just west of Herring Bay to Patuxent River, but west of the Patuxent it is almost completely obscured by younger deposits. The boundaries of the Choptank formation in Calvert County are better known than in any other portion of southern Maryland, but west of the Patuxent have been determined more by calculation than by observation. They are believed, however, to be approximately correct and are fixed as accurately as present knowledge warrants. In its broader relations the formation extends from Virginia northwestward across Maryland and Delaware into New Jersey, where it has an extensive development.

Character of Materials.—The materials composing the Choptank formation are extremely variable. They consist of fine yellow quartz sand, bluish-green sandy clay, slate-colored clay, and, at some places, ledges of indurated rock. In addition to these materials, abundant fossil remains are disseminated throughout the formation. The sandy phase is characteristic of the formation in this county.

Paleontologic Character.—Although the Choptank formation is abundantly supplied with fossils, these are for the most part concen-

trated in two well-defined beds which seem to be distributed very extensively through the areas of the deposit, though not represented in Prince George's County. The fossils of this formation have recently been fully described and illustrated in the two volumes on the Miocene published by the Maryland Geological Survey.

Strike, Dip, and Thickness.—The strike of the Choptank formation is in general from northeast to southwest; but as a result of erosion, particularly on the Western Shore of Chesapeake Bay, the outcrop is very sinuous and the strike appears to change locally.

The dip does not seem to be constant throughout the extent of the formation. In Calvert County, where the Choptank is best exposed, the northern portion of the outcrop, down to Parker Creek, seems to lie almost horizontal; but farther south the formation at its base dips southward at the rate of about 10 feet to the mile, so that toward the south it occurs at lower and lower levels until in the southern portion of its area it is found in river bottoms and finally disappears beneath tide. The best place in this state to examine the dip of this formation is along the Calvert Cliffs bordering Chesapeake Bay between Parker Creek and Point of Rocks. Here an almost unbroken exposure of the Choptank may be seen dipping gradually toward the southeast.

The thickness of the Choptank formation is variable. In the well section at Crisfield, mentioned in connection with the description of the Calvert formation, the Choptank is more than 100 feet thick, so that, like the Calvert, it thickens as it passes down the dip.

Stratigraphic Relations.—The Choptank formation lies unconformably upon the Calvert formation. The unconformity is in the nature of an overlap, but is not easily discernible even where the contact is visible. The best place to observe the unconformity is in the portion of the Calvert Cliffs just below the mouth of Parker Creek. Even here it can not be seen from the beach, but is visible from a boat a short distance from the shore. This unconformity is also proved by the fact that at the above-mentioned locality the fossiliferous bed which lies lowest in the Choptank formation rests upon the Calvert, while at Mount Harmony, in Calvert County, and

farther north the upper fossiliferous bed of the Choptank rests upon the Calvert formation. How far this unconformity continues down the dip after the beds disappear from view is not known, as the data from well records are too meager to permit any conclusion to be drawn from them. Above the Choptank is the St. Mary's formation, which is not represented in this county.

Subdivisions.—The Choptank formation is subdivided into five zones, which are distinguished from one another by the character of material and the fossils they contain. These zones, together with their fossil contents, have been fully described in the State report on the Miocene of Maryland.

The Pliocene (?).

The Lafayette Formation.

The name Lafayette was proposed by Hilgard in 1891[1] to replace the term Orange sand, used in Tennessee and Mississippi, and the term Appomattox, which had been applied to the deposits of the Atlantic Coast. The name is derived from Lafayette County, Miss., a region where the formation is well developed. The exact correlation of the formation has not been definitely settled, as its meager fauna has furnished little clue to its age. Its general character, firmly indurated layers, and occasional greatly decomposed pebbles suggest a formation much older than any known Pleistocence deposit of the province, and hence furnish evidence for a provisional reference to the Pliocene.

Areal Distribution.—The Lafayette forms the surface cover over the principal stream divide of the southern portion of the county. At one time, however, it probably formed a mantle over the entire area, for outliers are found north of Washington. If such was the case, the Lafayette must originally have rested upon the exposed edges of all the earlier formations represented in this region, but erosion has so reduced its area that it is now in contact principally with the Miocene, although in small areas it rests upon the Patuxent

[1]Am. Geologist, vol. VIII, 1891, pp. 129-131.

FIG. 1.—VIEW SHOWING INDURATED LEDGE OF FOSSILIFEROUS MIOCENE SAND NEAR MAGRUDER FERRY.

FIG. 2.—VIEW SHOWING SURFACE OF LAFAYETTE PLAIN, NEAR CHELTENHAM.

formation and the ancient crystalline rocks. The Lafayette plain is in reality the oldest and highest of a series of five plains which were developed at successively lower levels during various epochs ranging in time from Pliocene (?) to Recent. It extends almost uninterruptedly from the District of Columbia line to the southern boundary of the county and forms one of the most striking topographic features in this area. Northeast of the District of Columbia the Lafayette is represented by a few outliers, the largest of which occurs in the vicinity of Laurel. It covers the higher portions of the divide between the Patuxent and Potomac river systems and thus becomes the most conspicuous formation of the region.

Character of Materials.—The Lafayette formation is composed of gravel, sand, and loam. These materials were so imperfectly sorted by the waves of the Lafayette sea that they are now found intermingled in varying proportions. Although there is a rough bipartite division in the deposit as a whole, the gravel occurring in greater abundance at the base and the sand and loam at the top of the formation, yet these elements are mixed together in a confusing manner. No particular kind of material is confined to any definite stratum, but all kinds may occur anywhere throughout the section. Irregular beds or lenses of loam, sand, or gravel also occur and are exposed in many places throughout the county. The gravels are considerably decayed and are usually rather small, but in the vicinity of Washington they become very coarse and are embedded in a coarse, compact sand or very stiff, clayey loam. The appearance of the gravels also changes from place to place; near Washington they are almost invariably covered with a dark-brown ferruginous coating, but farther south the amount of iron decreases considerably and the coating of iron oxide is practically absent. The heterogeneous character of the material furnishes evidence of the varied sources from which it has been obtained. Pebbles of quartz and crystalline rocks indicate the Piedmont as the source; broken iron crusts were derived from the Paleozoic formations farther west; and finally, decayed blocks of Newark sandstone are occasionally observed. While all of these various materials are present, the gravels are composed principally of quartz.

Sand forms a rather unimportant part of the Lafayette deposits. Such as is present seems to have been derived mainly from the Potomac beds. Lenses of sand occur at many places in the gravel deposits, but do not commonly form beds of great thickness or extent. The sand usually serves as the matrix for the gravels or else is intimately mixed with the loam.

Throughout the county the Lafayette is capped by a deposit of loam varying in thickness from a few inches to 10 feet or more, with an average of about 5 feet. Near Washington this loam contains considerable iron and has here and there a decided orange color. To the east and south this color becomes much less pronounced. In many places the loam resembles the loess of the upper Mississippi Valley in color and also in texture. On the broad Lafayette plain in the southern part of the county the loam shows a very pronounced mottling of drab and brick-red. This is particularly noticeable when the material is wet. It is seen in numerous road cuts, especially west of Brandywine. The Lafayette loam is in some places highly argillaceous, in others decidedly arenaceous. As a general rule, it is of very fine texture. Although the loam capping is relatively free from bands of gravel, they are not entirely absent. Single pebbles are not uncommon in the loam and locally there are well-defined beds of gravel and sand. The following section, taken 1½ miles southeast of Piscataway, makes these relations clearer:

Section 1½ miles southeast of Piscataway.

LAFAYETTE:	Feet.
Fine grayish-yellow loam	5
Medium-coarse gravel in a matrix of gray sand	4
Yellow cross-bedded sand	3
Unassorted gravel mixed with gray sand	5
	17

Physiographic Expression.—As described under "Topographic features," the deposits of this formation form a plain of deposition which is well-developed in many places in the Coastal Plain and slopes gradually toward the sea. In the vicinity of Anacostia the base of the Lafayette plain is at a height of 280 feet and its surface at 300 feet. At Charlotte Hall in St. Mary's County, 30 miles to the south, the base is not visible, but the surface lies at

an altitude of about 200 feet. This shows, therefore, a difference of 100 feet in 30 miles, or a surface slope toward the sea of about 3 feet to the mile. So slight and gradual a decline in elevation might be attributed to the original attitude of the material when it was deposited were it not for the fact that the Sunderland terrace, which wraps about the base of the Lafayette, has suffered a deformation of 20 feet, or about 8 inches to the mile, throughout the same region, and the Wicomico appears also to have been affected by a slight tilting. It is probable, therefore, that the present slope of the Lafayette formation is due partly to its original attitude and partly to subsequent tilting.

Paleontologic Character.—Fossils are practically lacking in the Lafayette deposits of the Atlantic Coast region none being found in this area. Pebbles containing Paleozic fossils are present in the formation at many places throughout the district, but are of importance only because they show the source of the materials.

Thickness.—The thickness of the Lafayette is somewhat variable. In its northwesternmost exposures the formation shows a thickness of 3 to 10 feet, the amount increasing somewhat toward the southeast. Over the broad plain in the vicinity of Brandywine the Calvert, which is the next subjacent formation, is reached at a depth of about 28 feet. The maximum thickness of the Lafayette in this county probably does not exceed 40 feet.

Stratigraphic Relations.—A very marked unconformity separates the Lafayette from all underlying formations. In one place or another within the Coastal Plain province it overlies almost every older formation represented in the region, and thin remnants are present in many places on the eastern borders of the Piedmont Plateau. In Prince George's County it rests mostly upon the Calvert and Choptank formations and is, in the main, a surface deposit, although locally it in all probability dips beneath beds of Pleistocene age.

The Pleistocene Formations.

THE COLUMBIA GROUP.

The Pleistocene formations of the Atlantic Coastal Plain are united under the name Columbia group. They have many characteristics in common, owing to their similar origin. They consist of gravel, sands, and loam which are stratigraphically younger than the Lafayette formation. The Columbia group in this area comprises three formations, the Sunderland, Wicomico, and Talbot. They appear as the facings of different plains or terraces, possessing very definite physiographic relations (see fig. 2), as described under the heading "Topographic features."

On purely lithologic grounds it is impossible to separate the three formations composing the Columbia group. The materials of all have been derived mainly from the older formations which occur in the immediate vicinity, but include more or less foreign material brought in by streams from the Piedmont Plateau or from the Appalachian region beyond. The deposits of each of these formations are extremely varied, their general character changing with that of the underlying formations. Thus deposits belonging to the same formation may, in different regions, differ far more lithologically than deposits of two different formations lying in proximity to each other and to the common source of most of their material. Cartographic distinctions based on lithologic differences could not fail to result in hopeless confusion. At some places the older Pleistocene deposits are more indurated and their pebbles more decomposed than those of the younger formations, but these differences can not be used as criteria for separating the formations, inasmuch as loose and indurated, fresh and decomposed materials occur in each of them.

The fossils found in the Pleistocene are far too meager to be of much service in separating the deposits into distinct formations, even though essential differences between some of them may exist. It is the exceptional and not the normal development of the formations that has rendered the preservation of fossils possible. These consist principally of fossil plants that were preserved in bogs, but in a few

places about Chesapeake Bay local Pleistocene deposits contain great numbers of marine and estuarine mollusks.

At almost every place where good sections of Pleistocene materials are exposed the deposit from base to top seems to be a unit. At some places, however, certain layers or beds are sharply separated from the underlying beds by irregular lines of unconformity. Some of these breaks disappear within short distances, showing clearly that they are only local phenomena in the same formation, the result of contemporaneous erosion by shifting shallow-water currents. Whether all these breaks would thus disappear if sufficient exposures occurred to permit the determination of their true nature is not known. An additional fact which indicates the contemporaneous erosive origin of these unconformities is that in closely adjoining regions they seem to have no relation to one another. Inasmuch as the Pleistocene formations lie in a nearly horizontal plane it would be possible to connect these separation lines if they were subaerial unconformities due to an interval of erosion. In the absence of any definite evidence that these lines are stratigraphic breaks separating two formations, they have been disregarded. Yet it is not improbable that in some places the waves of the advancing sea in Sunderland, Wicomico, and Talbot time did not entirely remove the beds of each preceding period of deposition over the area covered by the sea in its next transgression. Especially would materials laid down in depressions be likely to persist as isolated remnants which later were covered by the next mantle of Pleistocene deposits. If this is the case each formation from the Lafayette to the Wicomico is probably represented by fragmentary deposits beneath the later Pleistocene formations. Thus in certain sections the lower portions may represent an earlier period of deposition than that of the overlying beds. In regions where pre-Quaternary materials are not exposed at the bases of the escarpments each Pleistocene formation near its inner margin probably rests upon the attenuated edge of the next younger formation. Inasmuch as lithologic differences afford insufficient criteria for separating these late deposits, and as sections are not numerous enough to furnish distinctions between local interformational unconformities and widespread unconformities result-

ing from an erosion interval, the whole mantle of Pleistocene materials occurring at any one locality is referred to the same formation. The Sunderland is described as overlying the Cretaceous, and Tertiary deposits and as extending from the base of the Lafayette-Sunderland escarpment to the base of the Sunderland-Wicomico escarpment. The few deposits of Lafayette materials which may possibly underlie the Sunderland are disregarded because they are unrecognizable. Similarly the Wicomico is described as including all the gravels, sands, and clays overlying the pre-Lafayette deposits and extending from the base of the Sunderland-Wicomico escarpment to the base of the Wicomico-Talbot escarpment. Perhaps, however, materials of Lafayette and of Sunderland age may underlie the Wicomico in places. In like manner the Talbot may here and there rest upon deposits of the Lafayette, Sunderland, and Wicomico.

The Sunderland Formation.

This formation has been named from the little village of Sunderland, Calvert County, near which it is typically developed. The name was first applied to the formation by G. B. Shattuck in May, 1901.[1] The Sunderland corresponds approximately with the Earlier Columbia of McGee and with parts of the Bridgeton and Pensauken of Salisbury. Its Pleistocene age is indicated by the modern appearance of its plant remains and by its relation to the next younger formation, the Wicomico, in which boulders bearing glacial striæ have been found.

Areal Distribution.—The Sunderland formation is developed as a terrace or plain which occupies the tops of the secondary stream divides below the Lafayette formation, between the Patuxent and Potomac rivers. Since its deposition it has suffered more erosion than either of the two younger formations, but enough of it still remains within the area to make its mapping possible and to establish its relations to the other deposits. The surface of the Sunderland plain varies in altitude from 200 feet in the northern and central

[1]Johns Hopkins Univ. Circ. No. 152.

portions of the county to 180 feet in the southern portion. Throughout this tract the original surface of the formation was nearly level, but the streams which now flow across it have locally produced a gently rolling surface. In the vicinity of Laurel there are many gravels present in the surface soils that may belong to this formation though not so represented on the map. The Potomac strata in that locality contain gravel bands, and it seems more probable that the surficial gravels are the residual materials of these Cretaceous beds or of the Lafayette formation that occurs in the immediate vicinity.

Character of Materials.—The materials which compose the Sunderland formation consist of clay, sand, gravel, and ice-borne boulders. As explained above, these materials as a rule do not lie in well-defined beds, but grade into each other both vertically and horizontally. The coarser materials, with the exception of the ice-borne boulders, have in the main a cross-bedded structure, but the clays and finer material are either developed in lenses or horizontally stratified. The erratic ice-borne blocks are scattered through the formation and may occur in the gravel, sand, or loam. The coarser material throughout the formation tends to occupy the lower portions and the finer the upper portions, but the transition from one to the other is not marked by an abrupt change, and at many places the coarse materials are present above and the finer materials below. As a whole the material is coarser on the western side of the County, in the Potomac basin, than elsewhere. In the vicinity of Congress Heights, the gravels of the Sunderland are rather commonly cemented by ferruginous material. The ferruginous conglomerate used in the wall about the grounds of St. Elizabeth's Asylum was obtained from beds of consolidated Sunderland deposits. Many of the pebbles of the Sunderland are much decayed, but in general they show less decomposition than the Lafayette gravels.

Physiographic Expression.—The Sunderland deposits occupy and form the Sunderland plain mentioned in the discussion of topography (p. 80). This plain is separated from the Lafayette terrace by a well-defined scarp. This scarp has suffered considerable modification since its formation, and where it was not prominent it has

been transformed to a gently rolling surface or has been lost altogether. At Charlotte Hall, a short distance beyond the southern margin of the county, this scarp is preserved in nearly its original sharpness. It is also visible south of Bryantown in Charles County and north of Aquasco. In all these localities the original scarp was low, not exceeding 20 feet in height, but at Congress Heights, south of Anacostia River, the scarp separating the Lafayette and Sunderland surfaces is over 60 feet high and is the finest and best defined of all the ancient escarpments of this portion of the Coastal Plain. At Congress Heights the surface of the Lafayette plain lies at an altitude of about 260 feet. From this height a steep slope descends, cutting through the Lafayette and underlying Miocene beds, to the 200-foot contour, where the broad Sunderland plain abuts against the scarp and slopes gently away from it. The Sunderland formation is also usually separated from the Wicomico formation by a well-pronounced scarp; this is discussed in the section following, which is devoted to the Wicomico.

As already stated, the Sunderland plain stands at a height of 200 feet near Anacostia and of 180 feet at Charlotte Hall, 30 miles to the southeast. The surface of this plain thus slopes southeastward at the rate of 8 inches to the mile. It also slopes gently toward the larger estuaries.

Paleontologic Character.—No fossils have been discovered in the deposits of Sunderland age in Prince George's County, though plant remains have been found at several places in the State. A few miles to the east of the Patuxent River a typical Sunderland plant bed is exposed along the Chesapeake Beach Railroad in the extreme southwest corner of Anne Arundel County between Wilson and Owings Station. At this place a plant bed occurs at the base of the deposit. It consists of a stratum of black clay about 3 feet in thickness, in which are numerous small lignitized stems.

Thickness.—Although the materials of the Sunderland lie at varying elevations above sea level in Prince George's County, the thickness of the formation is not great at any point. That the deposits were laid down on a sloping and dissected plain is proved by many

well records and observations which show that the surface of the underlying formations rises in passing from the stream valleys to the divides. Consequently, the thickness of the Sunderland can not be determined by the elevation of the deposits, but the evidence furnished by the excavations and well records on the stream divides shows that the formation probably has an average thickness of about 35 feet.

Stratigraphic Relations.—Throughout the Coastal Plain the Sunderland overlies unconformably various formations of Cretaceous, and Tertiary age. In Prince George's County it lies unconformably upon the Aquia, Nanjemoy, Calvert, and Choptank formations. It is not improbable that the edges of the Lafayette formation extend beneath part of the Sunderland deposits, although this can not be determined because of the absence of any definite line denoting a stratigraphic break and because of the similarity of the materials of the two formations.

The Wicomico Formation.

This formation receives its name from Wicomico River, in southern Maryland. The name was proposed by G. B. Shattuck in May, 1901.[1] The Wicomico represents the upper part of the Later Columbia of McGee and Darton and a part of the Pensauken of Salisbury. The presence of ice-borne boulders furnishes evidence for its contemporaneity with the ice invasion, although the particular drift sheet with which the formation should be correlated has not yet been determined.

Areal Distribution.—The next younger formation of Pleistocene age is the Wicomico. Like the Sunderland, it was deposited on a terrace or plain. It lies topographically lower than the Sunderland, wraps around it like a border, and extends up the principal stream estuaries which penetrate it. In Prince George's County the Wicomico formation is distributed in the stream valleys through the entire area, and is especially well developed in the basin of Patuxent River.

[1]Johns Hopkins Univ. Circ. No. 152.

Character of Materials.—The materials which constitute the Wicomico formation are similar to those found in the Sunderland—in fact, many of them have been derived from that formation. They consist of clay, peat, sand, gravel, and ice-borne boulders. The distribution of these materials is similar to that of those in the Sunderland in that they grade one into another both vertically and horizontally, the coarser materials preponderating at the base of the formation and the finer materials toward the top. At some places the materials are very much decayed, as in the Sunderland.

In the Potomac Valley near Washington boulders carrying glacial striæ have been found in the Wicomico formation. The great size of these boulders and their occurrence with much finer materials furnish evidence of their transportation by floating ice.

The amount of loam present in the Wicomico is exceedingly variable. Wherever the loam cap is well developed the roads are very firm and the land is suitable for the production of grass and grain; but where the loam is present in small quantities or absent altogether the roads are apt to be sandy.

Physiographic Expression.—The Wicomico formation is developed in a terrace which is described in the section headed "Topographic features" as the Wicomico plain. This plain is separated from the Sunderland terrace, which lies above it, by a scarp, usually above 20 feet in height, which is one of the most constant and striking topographic features in the region. The Wicomico plain is in turn in most places separated by an escarpment from the Talbot terrace, which wraps around it at a lower elevation. From the Sunderland-Wicomico escarpment the surface of the Wicomico formation slopes away gently toward the surrounding waters in the manner of a wave-built terrace. In the northern portion of the county the surface of the Wicomico, at the base of this escarpment, lies at an elevation of about 100 feet, while in the southern portion the elevation of the corresponding surface is about 90 or 95 feet, indicating a very gentle slope toward the southeast. Since the Wicomico was deposited it has been subjected to considerable erosion and its originally level surface has been transformed, at least along the waterways, into a gently rolling one.

Paleontologic Character.—No good Wicomico fossil localities are known in Prince George's County, but in Anne Arundel County, about one mile southeast of Queen Anne (Hardesty), there is a peat bed within and just at the base of the formation. Here, at an elevation of 30 feet above the stream, there is a deposit of carbonaceous material about 20 feet thick. About 1½ feet of this is composed principally of peat. The leaf impressions are mainly of grasses and stems, but some insect remains and beetle-wing covers are also present. Some years ago a tooth of *Elephas Americanus* DeKay was found in Wicomico materials in the pits of the Washington Brick Company located in the northeastern portion of Washington, in the area bounded by Florida and Trinidad avenues and the Bladensburg turnpike. The tooth was obtained at a depth of 35 feet from the surface.

Thickness.—The thickness of the Wicomico formation is not at all uniform, owing to the uneven surface upon which it was deposited. It ranges from a few feet to 50 feet or more. The formation dips into the valleys and rises on the divides, so that its thickness is not so great as might be supposed from the fact that the base is in many places as low as 40 feet while the surface rises locally to 100 feet above sea level. Notwithstanding these irregularities the formation as a whole occupies an approximately horizontal position, with a slight southeasterly dip. The average thickness of the formation in this county is about 20 feet.

Stratigraphic Relations.—In this region the Wicomico overlies unconformably the granite-gneiss and the various formations of Cretaceous and Tertiary age. It is in many places in contact with the Sunderland on the one hand and with the Talbot on the other. It is probable that the Sunderland formation extends locally somewhat below the Sunderland-Wicomico scarp and may run out beneath and underlie the edge of the Wicomico formation where the two are in contact. In such places this contact between the Wicomico and Sunderland would be an unconformity.

The Talbot Formation.

Talbot County, Md., where the formation occupies a broad terrace bordering numerous estuaries, has furnished the name for this formation. It was first given by G. B. Shattuck in 1901.[1] The Talbot represents the lower part of the Later Columbia described by McGee and Darton and corresponds approximately to the Cape May formation of Salisbury. Its Pleistocene age is proved by the fossils found at Cornfield Harbor.

Areal Distribution.—The Talbot formation is well developed in Prince George's County. It occurs as a terrace of varying width extending from the Wicomico-Talbot scarp out to the edge of the surrounding waters. It is well distributed throughout the region, bordering the various estuaries and streams. Its most continuous and unbroken areas are situated in the valleys of the Patuxent and Anacostia rivers.

Character of Materials.—The materials which compose the Talbot formation consist of clay, peat, sand, gravel, and ice-borne boulders. As in the Sunderland and Wicomico deposits, these materials grade into each other both vertically and horizontally, and the formation exhibits the same tendency toward a bipartite division, with the coarser materials beneath and the finer materials above. There is, on the whole, much less decayed material in the Talbot than in the two preceding formations and as a result the formation has a much younger appearance than the other Pleistocene deposits.

In the western portion of the county, in the vicinity of Washington and Anacostia, the Talbot beds contain many large boulders which have been carried by ice and dropped in deposits of much finer material. Some of these boulders show their glacial origin in that they have been planed by the wearing action of the ice and bear glacial striae. Cross stratification is very common in the Talbot deposits. One of the best exposures of this structure can be seen in a shallow cut along the Chesapeake Beach Railroad about one-fourth mile from Patuxent River. Another good exposure of cross stratifi-

[1] Johns Hopkins Univ. Circ. No. 152.

FIG. 1.—VIEW SHOWING THE DISSECTED SURFACE OF THE SUNDERLAND PLAIN, IN THE VICINITY OF THE PATUXENT RIVER.

FIG. 2.—VIEW SHOWING MATERIALS OF THE TALBOT FORMATION OVERLYING EOCENE GREENSAND, NEAR PISCATAWAY.

eation in the Talbot occurs just north of Lyons Creek, in Anne Arundel County. The following section was taken on the banks of Anacostia River, near Washington:

Section on west side of Anacostia River south of Pennsylvania avenue, Washington, D. C.

TALBOT:

	Ft.	In.
Sandy loam, light yellow to brown in color.....	3	6
Fine yellow sand with here and there isolated pebbles or thin lenses of gravel 4 to 6 inches thick; gravel up to 6 inches in diameter.....	7	0
Mass of gravel of all sizes, unstratified, some several feet in diameter; yellow sandy matrix; striæ on gravels; materials generally fresh in appearance; a few small lenses of yellow sand free from gravel. In places iron crusts have formed in the sand and gravel, cementing them together. Amount exposed..	11	0
	21	6

Physiographic Expression.—The Talbot formation is developed as a terrace capping, forming the Talbot plain described under the heading "Topographic features." It wraps around the lower margin of the Wicomico terrace, from which it is separated in most places by a low escarpment. From the base of the Wicomico-Talbot scarp, which is at an elevation of 40 to 45 feet, the surface of the Talbot formation slopes gently toward the surrounding waters. This surface has chiefly, if not entirely, the initial slope which was imparted to it during its period of deposition. Usually this terrace is terminated by a low scarp cut by the waves of Chesapeake Bay or its estuaries, but locally it slopes gently to the water's edge. The Talbot formation has suffered less erosion than either the Sunderland or the Wicomico. It has been elevated above the water for so short a time that such streams as have found their way across its surface have not been able to change materially its original level character.

Paleontologic Character.—In the Maryland portion of the Coastal Plain there are a number of localities at which fossil remains of either plants or animals or both occur in the Talbot deposits. The only specimen of animal remains found in the Talbot deposits of Prince George's County consist of a bone of a mammoth determined by J. W. Gidley as the right humerus. It was found about 2¼ miles

northwest of Upper Marlboro at the road crossing of Cabin Branch near the Western Branch of the Patuxent River. It is now preserved in the museum of Georgetown University. Near Cornfield Harbor, at the mouth of Potomac River, the formation has yielded a great number of molluscan shells representing a varied fauna of marine and brackish-water origin. Practically all the plants and animals are forms which still exist in this or other regions.

Thickness.—The thickness of the Talbot formation is extremely variable, ranging from a few feet to 40 feet or more. The unevenness of the surface upon which it was deposited has in part caused this variability. The proximity of certain regions to the mouths of streams during the Talbot submergence also accounts for the increased thickness of the formation in such areas.

Stratigraphic Relations.—The Talbot rests unconformably, in different portions of the region, upon various older formations belonging to the Cretaceous or Tertiary systems. It may in places rest upon deposits of Lafayette, Sunderland, or Wicomico age, although no positive evidence has yet been found to indicate such relations to the older Pleistocene formations. The deposits occupy a nearly horizontal position, having only a slight slope toward Chesapeake Bay and its estuaries.

The Recent Deposits.

In addition to the four terraces already discussed, a fifth is now being formed by the waters of the rivers and the waves of the estuaries. This terrace is everywhere present along the water's edge, extending from a few feet above tide to a few feet below. It is the youngest and topographically the lowest of the series. Normally it lies beneath and wraps about the margin of the Talbot terrace, from which it is separated by a low scarp that as a rule does not exceed 15 to 20 feet in height. Where the Talbot formation is absent, the Recent terrace may be found at the base of either of the other three terraces. In such places, however, the scarp which separates them is higher in proportion as the upper terrace is older. Peat, clay,

sand, and gravel make up the formation and these materials are deposited in deltas, flood plains, beaches, bogs, dunes, bars, spits, and wave-built terraces.

Interpretation of the Geological Record.

Almost all the formations which occur within Prince George's County have a much more extensive development in the regions beyond its borders. If study were confined to the area of this county alone many of the conclusions drawn from such investigations might be unsatisfactory and erroneous. The geologic history of the county, which is here outlined, has been based on work done not only in this area but also throughout the North Atlantic Coastal Plain from Raritan Bay to Potomac River and in certain localities in Virginia and the Carolinas.

A study of the geologic history of the county shows that it has been long and complicated. This is indicated by the many different kinds of strata represented and by the relations which they bear to one another. There are deposits that were formed in fresh or brackish water; others that show evidence of their deposition in marine waters, some in water of shallow depth, others in deep water; while breaks in the conformity of the different strata indicate that from the time of the formation of the earliest beds down to the present day the region has undergone many elevations and subsidences.

Sedimentary record of the crystalline rocks.

In this section rocks older than the Cretaceous are present only in the Piedmont Plateau. It is exceedingly difficult to interpret the past history of the Piedmont region for the reason that the whole area has been subjected to many great changes which have essentially modified the original materials; yet the studies of Williams, Keith, Mathews, Bascom, and others have revealed many facts concerning the original condition of the rocks now occupying this region. Nearly all the rocks of the Piedmont are metamorphic in character. Many of these rocks were originally sedimentary deposits, but in the processes of metamorphism have now lost nearly all traces of their

original character. Consequently it is scarcely possible to explain the conditions under which they were originally deposited. Yet it may be said that a large portion of the area which the Piedmont metamorphic rocks now occupy was under water at one time, or perhaps many times, and received in some places deposits of sand and mud carried in by streams, while in other places beds of limestone were formed. It is not known how long this sedimentation continued or how many breaks took place between successive periods of deposition. It has been thought by most recent workers in the Piedmont region that the rocks there include not only representatives of the Archean, to which most of the earlier geologists referred them, but of the Cambrian and Ordovician as well. These old rocks have been broken through in many different places by sheets and dikes of igneous material. Thus the Piedmont metamorphics comprise representatives of both igneous and sedimentary rocks. The structure of these rocks when first formed was undoubtedly much more simple than at present, but they have been repeatedly subjected to various processes of metamorphism by which the beds have been folded and crumpled and the original mineral composition has been greatly changed.

There is no evidence to show a submergence of this area during the latter part of the Paleozoic era nor during the Triassic period. It probably remained as a land mass during most of this time, furnishing terrigenous materials to the Paleozoic sea to the west and to the Atlantic Ocean far to the east. It is of course possible that it may have been depressed beneath the ocean waters and covered with sediments many times, but, if so, later erosion has removed such deposits from the crystalline surface.

SEDIMENTARY RECORD OF THE LOWER CRETACEOUS.

The earliest of the known unconsolidated deposits lying upon the floor of crystalline rocks belong to the Patuxent formation of the Potomac group. It indicates a submergence of the Coastal Plain in this region of sufficient extent to cover the whole area with shallow water. The cross-bedded sands and gravels furnish evidence of shift-

ing currents, as do also the abrupt changes in the character of the materials, both horizontally and vertically. The presence of numerous land plants in the clays shows the proximity of the land.

The deposition of the Patuxent formation was ended by an uplift or warping in which many of the stream valleys were occupied for a portion of their courses by bogs and swamps of the Arundel formation. In these marshes there was an extensive development of plant life and in them also were deposited iron ores that are now of considerable value. After an uplift and interval of erosion the land was again depressed beneath sea level. Physical conditions similar to those which had prevailed during Patuxent time existed during this period of submergence, in which the Patapsco formation was laid down. Dicotyledonous plants, which are very rare and primitive in structure in the Patuxent deposits, are abundant in the Patapsco and belong to higher types. This seems to indicate that a long time intervened between the two periods of deposition, during which the land flora of the region materially changed. After the deposition of the Patapsco formation the region again became land through an upward movement which drained all the previously existing estuaries and marshes. Erosion at once became active and the Patapsco surface was dissected.

SEDIMENTARY RECORD OF THE UPPER CRETACEOUS.

A downward land movement again submerged the greater portion of the region, leaving only a very narrow strip of Patapsco deposits above water. The Raritan formation was next deposited, under conditions very similar to those which had existed during the previous submergence. Raritan deposition was terminated by an uplift which again converted the entire region into land.

The widespread development of shallow-water deposits, everywhere cross-bedded and extremely variable in lithologic character, and the presence throughout these deposits of land plants furnish some evidence that sedimentation took place not in open ocean waters but in brackish or fresh-water estuaries and marshes that were indirectly connected with the ocean, which may have at times locally

broken into the area. Some land barrier to the east of the present shore line probably existed and produced these conditions, but its position and extent can not be determined.

The period during which the Magothy deposits were formed was one of transition from the estuarine or fresh-water conditions of Patapsco and Raritan time to the marine conditions under which the Matawan and Monmouth were laid down. The great variability in the lithologic character of the materials, the coarseness of the sands and gravels, and the cross-bedding all suggest conditions similar to those of the preceding periods. On the other hand, the local pockets of glauconitic sand and the presence of marine invertebrates suggest the marine conditions of the late Cretaceous. The probability is that over most of the area where Magothy deposits are now present Potomac conditions prevailed during the greater part of the period and in some places perhaps during the whole of it, but that occasionally, through the breaking down of the land barriers which had kept out the ocean, there were incursions of sea water, bringing in marine forms of life.

At the close of Magothy time the region was uplifted and a period of erosion was inaugurated. During this erosion interval comparatively small amounts of material were removed. In some places it is impossible to establish definitely any stratigraphic break between the Magothy and the Matawan. This may be because the erosion interval was comparatively short or because the elevation of the land above the water was so slight that it did not permit the streams to cut channels in the recently formed deposits.

Not until late Cretaceous time did a downward movement occur of sufficient extent to permit the ocean waters to transgress widely over this region. During the Matawan and Monmouth epochs probably all of the county was beneath the ocean. The streams from the low-lying land evidently carried into the ocean at this time only small amounts of fine sand and mud, which afforded conditions favorable to the production of glauconite and permitted the accumulation of the greensand beds that are so characteristic of the Upper Cretaceous deposits along the Atlantic Coast. During this time very slight changes took place along the continental border, although

elevation was probably proceeding slowly, as the Matawan and Monmouth formations are found outeropping farther and farther to the southeast.

After the deposition of the Monmouth formation land movements again caused the shore line to retreat eastward, but to what point is not definitely known. Farther north, in New Jersey, deposition still continued in some places, for the Rancocas formation, which overlies the Monmouth formation and is not recognizable in the Maryland area, is there overlain by another and later deposit of Cretaceous age, the Manasquan formation.

SEDIMENTARY RECORD OF THE EOCENE.

At the close of the Cretaceous period the recently deposited sediments were uplifted to form a land mass and sedimentation was succeeded by erosion. In early Tertiary time a depression carried most of the region again beneath the waters of the ocean and the Eocene deposits were formed. The great amount of glauconite present in these formations indicates that the adjacent land mass must have been low and flat, so that the streams carried only small amounts of terrigenous material. The water in which this was dropped was doubtless only a few hundred fathoms deep, as glauconite is not produced at great depths. The land-derived materials at the beginning of the Eocene consisted of small, well-rounded pebbles which were deposited in several places in the region; but later the materials carried consisted of fine sand or clay. Many forms of animal life existed in these waters and their remains now compose layers of marl several feet in thickness.

Studies of the fossils found in the Eocene deposits indicate that there were many changes in the fauna during this time. These changes were probably influenced to a greater or less extent by variations in physical environment, yet the character of the deposits themselves gives little evidence of such changes. Instead it seems that the conditions under which the Eocene deposits were produced were remarkably uniform, considering the great length of time which elapsed from the beginning to the close of the period.

SEDIMENTARY RECORD OF THE MIOCENE.

Eocene sedimentation was brought to a close by an uplift by which the shore line was carried far to the east and probably all of the present State of Maryland became land. This was followed by a resubmergence and another cycle was commenced. The deposits of the Miocene were laid down upon the land surface which had just been depressed beneath the water. Sluggish streams brought in fine sand and mud, which the waves and ocean currents spread over the sea bottom.

Near the beginning of Miocene submergence, certain portions of the sea bottom received little or no materials from the land, and the water in those places was well suited as a habitat for diatoms. These must have lived in the waters in countless millions, and as they died their silicious shells fell to the bottom and produced the beds of diatomaceous or infusorial earth which are so common in the lower part of the Calvert formation. Many Protozoa as well as Mollusca lived in the same waters and their remains are plentifully distributed throughout the deposits. During the Miocene epoch the conditions seem to have been favorable for animal life, as may be inferred from the great deposits of shell marl which were then formed.

After the deposition of the Calvert formation the region was again raised and subjected to erosion for a short period, and then sank once more beneath the sea. The Choptank formation was laid down contemporaneously with the advancing ocean. This formation lies unconformably upon the Calvert, and farther north transgresses it. In neighboring regions to the south of this county a third Miocene formation, the St. Mary's, was deposited conformably upon the Choptank at a later period.

SEDIMENTARY RECORD OF THE LAFAYETTE FORMATION.

At the close of the Miocene the entire region was uplifted to form land. Streams at once began to carve valleys on the featureless surface. These conditions continued until the country was reduced approximately to a base-level, so that the weathered products of the Piedmont were not carried off by the sluggish streams. Then a sub-

sidence occurred which again brought the region under water. Coincident with the subsidence there seems to have been a slight elevation and tilting of the region west of the shore line. The heads of the streams were given renewed force, enabling them to carry down and spread over this region large quantities of gravel and sand, derived from the Piedmont and Paleozoic formations to the west.

The evidence for the source of the material is found in many different pebbles whose origin can be traced by their lithologic character or the fossils they contain. In the vicinity of Washington many of the gravel deposits contain fossils of Devonian and Carboniferous age brought from regions beyond the Blue Ridge. These fossils show that Potomac River had extended its drainage basin westward to those regions. During the submergence beneath the Lafayette sea, conditions were not uniform over the entire area, as gravel deposits were forming in some places at the same time that the clay beds were being deposited in others adjoining. Yet on the whole sedimentation was remarkably uniform throughout the area, considering the circumstances under which it took place. Over the former land surface a fairly persistent capping of gravel was deposited. But land movements were again taking place slowly. The velocity of the streams was checked so that gravel could no longer be carried down except in occasional freshets. Fine sand and loam were laid down over the gravel which had been previously deposited. This loam, which is so extensively developed over a large portion of Prince George's County, marks the last period of Lafayette sedimentation. It marks also the last time that the entire region was submerged beneath the ocean waters.

SEDIMENTARY RECORD OF THE PLEISTOCENE.

At the close of the Pliocene epoch the region was raised again and extensively eroded, and was then lowered and received the deposits which constitute the first member of the Columbia group. The Sunderland, Wicomico, and Talbot formations, which make up this group, are exposed as a series of terraces lying one above the other throughout the North Atlantic Coastal Plain from Raritan

Bay to Potomac River, as well as in Virginia and probably still farther south. The key to the solution of the relations existing between the surficial deposits of Maryland lies almost exclusively in a correct correlation of these terraces. Much light may be thrown on this problem by a careful study of the Recent terrace now forming along the shores of the Atlantic Ocean and Chesapeake Bay and its tributaries. A discussion of this terrace is given below.

After the close of the post-Lafayette erosion period the Coastal Plain was gradually lowered and the Sunderland sea advanced over the sinking region. The waves of this sea cut a scarp against the existing headlands of Lafayette and older rocks. This scarp was prominent in some places and obscure in others, but may be readily recognized in certain localities. As fast as the waves supplied the material, the shore and bottom currents swept it out to deeper water and deposited it so that the basal member of the Sunderland formation, a mixture of clay, sand, and gravel, represents the work of shore currents along the advancing margin of the Sunderland sea; whereas the upper member, consisting of clay and loam, was deposited by quieter currents in deeper water after the shore line had advanced some distance westward and only the finer material found its way very far out. Ice-borne boulders are also scattered through the formation at all horizons.

After the deposition of the Sunderland formation, the country was again elevated above ocean level and erosion began to tear away the Sunderland terrace. This elevation, however, was not of long duration and the country eventually sank below the waves again. At this time the Wicomico sea repeated the work which had been done by the Sunderland sea except that it deposited its materials at a lower level and cut its scarp in the Sunderland formation. At this time also there was a contribution of ice-borne boulders which were deposited promiscuously over the bottom of the Wicomico sea. These are now found at many places embedded in the finer material of the Wicomico formation.

At the close of Wicomico time the country was again elevated and eroded, and then lowered to receive the deposits of the Talbot sea. The geologic activities of Talbot time were a repetition of those car-

ried on during Sunderland and Wicomico time. The Talbot sea cut its scarp in the Wicomico formation, or in some places removed the Wicomico completely and cut into the Sunderland or still older deposits. Deposits were made on its terrace, a flat bench at the base of this escarpment. Ice-borne boulders are also extremely common in the Talbot formation, showing that blocks of ice charged with detritus from the land drifted out and deposited their load over the bottom of the Talbot sea.

Embedded in the Talbot formation at many places there are lenses of drab-colored clay with plant remains. The stratigraphic relations of the lenses of clay occurring in the Coastal Plain show that they are invariably unconformable with the underlying formation and apparently so with the overlying sand and loams belonging to the Talbot. This relationship was very puzzling until it appeared that the apparent unconformity with the Talbot, although in a sense real, does not, however, represent an appreciable lapse of time and that, consequently, the clay lenses are actually a part of that formation. In brief, the clays carrying plant remains are regarded as lagoon deposits made in ponded stream channels and gradually buried beneath the advancing beach of the Talbot sea. The clays carrying marine and brackish-water organisms are believed to have been at first off-shore deposits made in moderately deep water, and later brackish-water deposits, formed behind a barrier beach and gradually buried by the advance of that beach toward the land.

The last event in the geologic history of the region was a downward movement, which is still in progress. It is this which has produced the estuaries and tide-water marshes that form conspicuous features of the existing topography. At the present time the waves of the Atlantic Ocean and Chesapeake Bay are at work tearing away the land along their margins and depositing it on a subaqueous platform or terrace. This terrace is everywhere present in a more or less perfect state of development, and may be observed not only along the exposed shores, but also on passing up the estuaries to their heads. The materials which compose it are varied, depending both on the detritus directly surrendered by the land to the sea and on the currents which sweep along the shore. On an unbroken coast the mate-

rial has a local character, while in the vicinity of a river mouth the terraces are composed of debris contributed from the entire river basin.

Besides building a terrace, the waves of the ocean and bay are cutting a sea cliff along their coast line, the height of the cliff depending not so much on the force of the breakers as on the relief of the land against which the waves beat. A low coast line yields a low sea cliff and a high coast line the reverse, and the one passes into the other as often and as abruptly as the topography changes, so that along the shore of Chesapeake Bay, high cliffs and low depressions occur in succession.

In addition to these features, bars, spits, and other shore formations of this character are being produced. If the present coast line were elevated slightly, the subaqueous platform which is now in process of building would appear as a well-defined terrace of variable width, with a surface either flat or gently sloping toward the water. This surface would everywhere fringe the shores of the ocean and bay, as well as those of the estuaries. The sea cliff would at first be sharp and easily distinguished, but with the lapse of time the less conspicuous portions would gradually yield to the leveling influences of erosion and might finally disappear altogether. Erosion would also destroy, in large measure, the continuity of the terrace, but as long as portions of it remained intact, the old surface could be reconstructed and the history of its origin determined.

THE MINERAL RESOURCES OF PRINCE GEORGE'S COUNTY

By

BENJAMIN L. MILLER.

Introductory.

The mineral resources of Prince George's County are neither extensive nor especially valuable, but the county contains some deposits that are of considerable economic importance, although they have not hitherto been very largely worked. Among the most important are clays, sands, gravels, building stone, glauconitic and shell marls, diatomaceous earth, and iron ore. In addition the soils contribute much to the value of the region, which is primarily an agricultural one, and abundant supplies of water, readily obtainable in almost every portion of the county, form a further part of its mineral wealth.

The Natural Deposits.

THE CLAYS.

Next to the soils the clays constitute the most valuable economic deposits of Prince George's County. As already stated in the discussion of the stratigraphy of the region, several of the formations contain considerable quantities of clay. These argillaceous beds are rather generally distributed throughout the county, but, so far as known, have in recent years been worked only in the vicinity of Washington. In colonial days bricks were made at a number of points throughout the region. The clays are found in each series of deposits represented in the region. For convenience they may be

discussed under the headings Cretaceous, Eocene and Miocene, and Lafayette and Pleistocene clays.

Cretaceous Clays.—The clays of the Potomac group are the most valuable within the region under consideration. Each formation of the group contains deposits of clay that are suitable for a variety of uses. Some clays from the Patuxent have been employed for the manufacture of common brick, fire brick, and terra cotta; the Arundel contains clays adapted to the manufacture of common brick, terra cotta, sewer pipes, and pottery; the Patapsco with its great variety of clays furnishes material suitable for the manufacture of common brick, fire brick, and other refractory ware, sewer pipes, and pottery; and the somewhat less argillaceous Raritan formation contains clays adapted to the manufacture of common brick, terra cotta, and fire brick.

Eocene and Miocene Clays.—Although argillaceous beds occur very commonly in the Eocene and Miocene strata of the county, they are generally too sandy to be of much economic importance. Considerable lime, derived from the numerous fossil shells which are either generally distributed throughout the sandy clay or concentrated in definite shell beds within the formations, also render these clays of less value. They are, however, very accessible, being exposed in the cliffs along the Patuxent River and in the valleys of tributary streams, and if a way of utilizing them should be discovered, they could be obtained in great quantities at little expense. The pink clay at the base of the Nanjemoy formation, known as the Marlboro clay, is the most valuable deposit of this group. It is about 25 feet thick and is exposed at many places in the stream valleys between Upper Marlboro and Piscataway. The clay is fairly plastic and no doubt could be used for making pressed brick, but is not plastic enough and is, besides, rather too sandy for pottery.

Lafayette and Pleistocene Clays.—As already stated, the Lafayette, Sunderland, Wicomico, and Talbot formations are generally composed of coarse materials at the base of the deposits, with a rather persistent loam cap which marks the last stage of deposition during each particular submergence. This surficial loam, which is very

similar in all four formations, has been extensively used for the manufacture of brick at many places in Virginia, the District of Columbia, Maryland, and southeastern Pennsylvania. It is generally not more than 3 or 4 feet in thickness, yet, because of its position, many beds no more than 1 or 2 feet thick can be worked with profit. The loam is widely distributed throughout the county and, though not quite coextensive with the formations of which it forms a part, it is present in almost every locality where the Lafayette and Pleistocene formations occupy flat divides that have not suffered much erosion since their deposition. In general the surface loam is adapted only to the manufacture of the common varieties of brick and tile, but in some places it is suitable for making a fair quality of paving brick. In this region the surface loam from the Talbot and Wicomico formations has been utilized at several different times for the manufacture of brick in the eastern part of Washington, near Anacostia River.

THE SANDS.

Inasmuch as the arenaceous phase predominates in almost every Coastal Plain formation represented in the region, Prince George's County contains an unlimited supply of sand. The sand of the Pleistocene and Lafayette formations is used locally for building purposes, but as it is so readily obtainable in all parts of the region no large pits have been opened.

In some places the quartz sands of the Miocene seem to be pure enough for glass making, suggesting the Miocene glass sands so extensively exploited in southern New Jersey, although they have never been used in that way in this region. Careful chemical analyses and physical tests, which have not been made, would be required to determine their usefulness in this industry.

The Magothy sands in the vicinity of Anacostia have long been worked and at present the most extensive sand pits of the region are opened in deposits of this age a short distance south of Anacostia. The sand is used for building and filtering purposes. In certain

places the Potomac deposits contain molding sand of fair grade, but it has not been used to any great extent.

Locally the Lafayette and Pleistocene sands are rich in ferruginous matter, which in some places cements the grains together, forming a ferruginous sandstone. Sands of this character possess a distinct value for road-making purposes, as they pack readily and make a firm road bed. Where the material can be easily obtained in large quantities, good roads can be very economically constructed with it

THE GRAVELS.

The Pleistocene, Lafayette, and Potomac formations contain numerous beds of gravel widely distributed throughout the region. Those of the Pleistocene and Lafayette deposits are generally rich in iron, which acts as a cementing agent, thus rendering them of considerable value as road metal. There are numerous gravel pits in the eastern part of the District of Columbia in deposits belonging to the Sunderland and Lafayette formations, and elsewhere in the vicinity of Washington there are smaller pits in deposits of Wicomico and Talbot age.

THE BUILDING STONE.

Prince George's County contains few beds of building stone of much importance, yet in places materials occurring within the region have been used locally. The granite-gneiss is the best building stone of the region and furnishes good material for foundations and other rough work. It is schistose and consequently can not be obtained in large masses, but for that reason can be very easily quarried. Some of the more massive beds furnish stones suitable for building, and in places, where the beds are thinner and more micaceous, flagstones can be obtained.

Although the Coastal Plain formations of the region are composed almost entirely of unconsolidated materials, yet locally indurated beds are not uncommon. In the absence of any better stone these indurated ledges furnish considerable material for the construction of foundations and walls. The best stone of this class is the firmly

cemented white sandstone occurring in the Raritan formation about 1 mile north of Collington. The shell beds of the Aquia in the vicinity of Upper Marlboro are so firmly consolidated that they furnish building stone, which though of poor grade is nevertheless suitable for rough work. The gravel bands of the Lafayette and Pleistocene are, in many places, so firmly cemented by iron oxide as to form pebble conglomerates of considerable strength.

THE MARLS.

Glauconite Marls.—The Eocene and Upper Cretaceous formations of the county are rich in deposits of glauconitic marls, which are of value as fertilizers. From New Jersey to North Carolina such deposits have been worked spasmodically since the early part of the last century, when their value was first determined, yet their importance in enriching the soil has never been generally recognized. They consist of quartz sand with an admixture of many grains of glauconite, a soft green mineral which is essentially a hydrous silicate of iron and potassium. On account of the glauconite, the marls are green in color and are commonly known as "greensand marls." They are rich in calcium carbonate derived from the shells which are abundant in the deposits, and chemical analyses usually show the presence of small amounts of mineral phosphates. The marls thus contain three important plant foods—potash, lime, and phosphates. Altogether these constitute only a small percentage of the entire content of the deposits, yet wherever the marls can be obtained at low cost, they furnish economical means for increasing soil fertility. Where the glauconite marls have been used it is claimed that their beneficial effects is much more lasting than that obtained by means of artificial fertilizers. Within the county many Eocene and Upper Cretaceous beds rich in glauconite outcrop along the sides of the stream valleys, extending in a belt diagonally across the county from the Patuxent River to Mattawoman Creek.

Shell Marls.—The shell marls of the Miocene and Eocene formations also possess valuable fertilizing properties for soils deficient in lime. In some places the shells are mixed with so much sand that

the lime forms only a small part of the deposit, but in others the amount of lime exceeds 90 per cent. Experiments show that better results have been obtained by the use of shell marl than by that of burned stone lime. The marl acts both chemically and physically and has a beneficial effect on both clayey and sandy soils. So far as known, the shell marls of this region have not been utilized, although they are well developed in many localities in the southern part of the county.

THE DIATOMACEOUS EARTH.

The principal workings of diatomaceous earth are at Lyons Creek, on the Anne Arundel side of the Patuxent River, although a bed of the material occurring at the base of the Calvert formation extends entirely across the southeastern portion of the county. Diatomaceous earth, on account of its porosity and compactness, is used in water filters and as an absorbent in the manufacture of dynamite. It is reduced readily to a fine powder and makes an excellent base for polishing compounds, while its nonconductivity of heat makes it a valuable ingredient in packing for steam boilers and pipes and in the manufacture of safes, the latter being the principal use to which it is put. It has been thought that this earth might be of use in certain branches of pottery manufacture which require refractory materials that have no color when burned. Heinrich Ries tested a sample of diatomaceous earth from Lyons Creek at cone 27 in the Deville furnace and found that the material fused to a drop of brownish glass. Its nonrefractory character is thus clearly demonstrated.

THE IRON ORE.

The Arundel formation in Maryland has long been known as the important iron-bearing member of the Potomac group and many mines have been worked in this formation in Prince George's, Anne Arundel and Baltimore counties. In colonial times these mines were of the greatest importance and many of the cannon used in the Revolution were made from Potomac iron ores. In recent years, how-

ever, these mines have decreased in importance, as most of them have been unable to compete with the Lake Superior ores and at the present time the only furnace using these ores is located at Muirkirk in the northern part of the county. The numerous immense pits now filled with water that can be seen in this region furnish evidence of the large quantity of ore that has been removed though the present operations are rather small.

The Muirkirk furnace has been in almost continuous use since 1847, and during that time has produced a great quantity of high-grade pig iron. After having been closed three years it was reopened in May, 1909, and is now producing about 400 tons of pig iron per month from about 1,200 tons of ore.

The ore is primarily an iron carbonate ore, though much of it has been altered to limonite or hematite near the surface. The oxidized ore is commonly called brown ore, while the carbonate ore is called white ore. The various stages of alteration can be readily seen in many specimens that have a shell of limonite or hematite with a central core of siderite. In other cases the alteration has affected the whole mass and no iron carbonate remains.

The ore occurs in the form of flattened irregular nodules arranged in rather definite layers in compact plastic clay. In certain cases the nodules are in close contact and there is a persistent band of iron ore, but in other places considerable clay occurs between the ore masses. In most mines there are several layers of the iron ore separated by beds of clay of varying thickness. The ore layers are seldom more than 12 to 14 inches thick. Where the ore is mainly iron carbonate the color of the clay is generally buff to drab, but where the ore has been oxidized the clay is colored red and yellow. Considerable lignite is contained in the clays associated with the ore and, in places, the ore itself contains pieces of lignite. Such ore is usually discarded because of the iron pyrite which it is apt to contain. It is well known that lignite acts as a precipitating agent of iron sulphide carried in solution and it is not uncommon to find pieces of lignite coated with iron pyrite.

The Arundel iron ore does not contain as high a percentage of iron as many of the iron ores used in this country, the average ore

running from 40% to 45% of metallic iron. Phosphorus and sulphur are unusually low, while manganese and silica are high. In one place a deposit of manganese ore has been found associated with the iron ore.

The ore is mined in a very primitive manner, all the labor being done by hand, and the ore hauled direct to the furnace. The usual method of working is by open pits, but in some cases the ore is removed through slope tunnels and shallow shafts, where the covering of barren clay is too thick to be profitably removed. In the tunnels and shafts very little timbering is required. Practically no capital is necessary for this kind of mining and most of the men engaged in the operations are lessees who pay a royalty of about 35 cents per ton to the owner of the land. In most places the operators are able to make fair wages, but no extensive mining can be done under these conditions. When the overburden becomes great the mine is abandoned and new openings made, so that it is not advisable to represent the working mines on the map. It is sufficient to say that they are all within a few miles of Muirkirk and Contee. At the furnace the ore is first roasted in order to eliminate any sulphur and also to convert the carbonate ore to the form of oxides.

The pig iron produced at Muirkirk has long been known for its tensile strength, and for this reason commands a higher price than any other pig iron manufactured in this country. There is a ready market for the product, which is used exclusively in the manufacture of special articles in which great strength is required. It has been used extensively by the United States government in the manufacture of cannon and is also in demand for car wheels, cylinders and various special kinds of steel. The claim is made by the proprietors of the furnace that their product is the strongest pig iron produced in the United States. The slag has been used as road metal in the vicinity of Muirkirk, and at the present time is being shipped elsewhere for this purpose.

THE PETROLEUM AND NATURAL GAS.

Rumors have been circulated at various times of the discovery of petroleum and natural gas at several different places within the

county. Although many of these rumors have been without foundation, small amounts of oil and gas have been observed in some places during the sinking of wells and in the vicinity of streams where there is seepage from porous beds. The gases generated by decaying vegetation have been mistaken in certain cases for natural gas, and the iridescent film of limonite that often appears on the surface of stagnant water in swamps and bogs has been supposed to be petroleum.

Borings have been made about 2 miles west of Annapolis in Anne Arundel County and about 1 mile south of Meadows in the search for oil and gas, but only traces were found. The Meadows well was sunk to a depth of 1511 feet, in all probability nearly to the crystalline rocks, thus practically proving the absence in that place of any considerable amounts of either of these materials. It is not probable that either petroleum or natural gas in paying quantities will be found within the limits of the county.

The Water Resources.

The water supply of Prince George's County is found in the streams and wells of the district. Many of the streams have been used at various times to furnish power for small mills, but little use has been made of them as sources of water supply. Washington obtains its water supply at a point some distance beyond the western boundary of the county. Laurel draws its supply of water from a small tributary of the Patuxent River. With the exception of the residents of these two cities the inhabitants of the region derive their water supply from springs and wells. The wells are divided into two classes—shallow dug wells and deeper bored wells, the deeper usually furnishing artesian water.

SPRINGS.

The gently sloping strata, the alternation of porous and impervious beds, and the great amount of dissection by streams which the region has undergone, all contribute to the formation of springs along the valley slopes. From these springs many of the inhabitants obtain

their entire supply of water, which is usually of excellent character. The spring water, as also that in wells, is in places highly charged with mineral matter, particularly iron, sulphur, and salt, and some such waters have been placed on the market. The most important mineral springs of the county from which waters have been sold are the Bladensburg Spa at Bladensburg and the Algonquin Springs at Oxon.

SHALLOW WELLS.

Nearly all the water supply of the county is derived from shallow wells, varying in depth from 15 to 35 feet. The water is contained in the rather coarse sand or gravel bed so commonly forming the basal stratum of the Pleistocene and Lafayette deposits. So generally is this the case that the depth of the shallow wells is usually a very good indication of the thickness of the surficial deposits. The surface water very readily penetrates the rather coarse surface materials until it reaches the less permeable underlying sedimentary or crystalline rocks. While some of it continues its downward course into these harder rocks a great deal flows along on their upper surface until it finds its way gradually into the streams. Hence wells sunk to this level are practically assured of a supply of water which, while seldom large in flow, is in seasons of average rainfall capable of furnishing sufficient water for ordinary purposes. Such shallow wells are necessarily dependent almost entirely on the amount of water which percolates through the Columbia and Lafayette deposits after rain storms, and are thus apt to be affected by droughts. After periods of heavy rainfall the water may rise in the wells within a few feet of the surface and then is very roily. At other times the wells may become dry, yet this does not often occur because of the fairly equable distribution of rainfall during the year. The supply is less variable over the broad divides or on level ground, where water is always nearer the surface, than in the regions of narrow stream divides, where the water finds an easy exit to the streams. In some places on the narrow divides in proximity to the major streams, it is necessary to sink wells to the depth of 100 feet or more in order to obtain a permanent supply of water.

Most of the water of the shallow wells is obtained at the base of the Lafayette or Sunderland deposits, as each of these formations covers large areas in which the streams have not yet cut through to the underlying deposits. There are also a number of shallow wells in the Patuxent River valley that derive their water supply from the base of the Talbot formation.

The water of the shallow wells usually contains so little mineral matter in solution that it is known as soft water. In many wells, no doubt, it does contain organic matter, yet there is little evidence to show that the water on this account is unfit for drinking purposes.

ARTESIAN WELLS.

Since water is so readily procured at shallow depths in almost all sections of the county and few establishments in the region require a large supply, there have not been many attempts to obtain artesian water. The area in which wells may be driven with the expectation of discovering a pressure sufficient to force the water to the surface is restricted to land lying 20 feet or less above tide. In areas above this altitude pump wells can probably be had from the water-bearing strata enumerated in the succeeding paragraphs, the water rising under artesian pressure above the point where it enters the well, but not overflowing. The somewhat meager data obtained in this and adjoining regions indicate the occurrence of water at the horizons described in the following paragraphs:

Waters of the Crystalline Rocks.—The waters contained in the crystalline rocks of the Piedmont Plateau are not of especial importance in this region, since these rocks occur at or near the surface in a very small area. In the vicinity of Washington some wells obtain water from these rocks, but to the northwest of this county they yield an important water supply. In general water occurs at less definite horizons in the crystalline rocks than in the Coastal Plain deposits, and it is consequently much more difficult to predict the depth to which wells must be sunk to obtain a good supply.

Beneath the unconsolidated sedimentary deposits of Prince George's County crystalline rocks similar to those exposed at the

surface in the northwestern portion of the county undoubtedly occur. This underlying consolidated rock mass is frequently spoken of as "bed rock." In general the crystalline rocks are less permeable than the overlying deposits and consequently check the downward passage of the percolating soil water, which tends to flow along on their surface or to collect in depressions. The surface of these old rocks dips rather uniformly to the southeast at an average rate of more than 100 feet to the mile. Along this crystalline floor much water flows to lower levels, and it therefore marks a good water horizon. Several artesian wells in the Coastal Plain derive an unfailing supply of pure water from this level. In Washington and the near vicinity water is obtained at this horizon in several wells, of which those at St. Elizabeth's Asylum are the largest. Five of the six artesian wells that supply the water system of Hyattsville probably obtain water at this horizon, which is reached at a depth of 250 feet. Though the water will overflow, the yield is increased by pumping. These five wells, together with another less than half as deep, are all pumped together and yield 130 gallons a minute.

Throughout the greater portion of the county this crystalline floor can never be very important as a water horizon because of its great depth. It was not reached in a 1511-foot boring about 1 mile south of Meadows, and it is probable that it lies as much as 2000 feet below tide over a large portion of the county.

Waters of the Lower Cretaceous Formations.—The Potomac deposits contain many beds of coarse material that constitute good water-bearing strata. Some of these sand and gravel beds lie between impervious deposits and thus furnish the requisite conditions for flowing artesian wells. Within the District of Columbia the beds belonging to the Potomac group are the principal water-bearing formations. The water does not seem to come from any one horizon of wide distribution, as is shown by the varying depths at which it is reached and by the failure to obtain any water in these beds at certain places. Wells that were unsuccessful in finding a satisfactory supply of water were the 360-foot well at the ice works and the 133-foot well at the Mount Vernon apartment house. On the other hand, at Hyattsville and in the vicinity there are several wells with small

flow that derive their supply of water from Potomac strata at depths between 100 and 112 feet. At Bladensburg flowing wells with capacities ranging from 1 to 15 gallons a minute have been obtained at depths between 73 and 100 feet; at the plant of the National Capital Brewing Company there is a 103-foot well that yields from 100 to 130 gallons a minute; at Langdon a flow of 40 gallons a minute was obtained at a depth of 140 feet; at the Reform School water was encountered at a depth of 270 feet; and near Chesapeake Junction a well which formerly flowed but now has to be pumped obtains its supply of water at a depth of 350 feet. In adjoining regions the Potomac strata have yielded an abundant supply of water. At Annapolis, on the grounds of the United States Naval Academy, a well sunk to the depth of 601 feet penetrated eight water-bearing strata within the Potomac beds, from three of which water flowed out at the surface, 8 feet above tide. At the lowest horizon, between 587 and 601 feet, a flow of water of 75 gallons a minute is obtained. The water contains iron, but is of excellent quality when filtered.

Waters of the Upper Cretaceous Formations.—The sandy strata of the Raritan and Magothy formations are in many places water-bearing. The water is apt to be strongly impregnated with iron, and locally with sulphur; consequently it is less desirable than that obtained from the Potomac deposits. At Upper Marlboro several flowing wells with an average depth of about 225 feet obtain a good supply of water from the Magothy. In some of the wells the amount of mineral matter in solution renders the water somewhat undesirable for drinking purposes, while in others the mineral matter seems to be present only in very small amounts. The Naval Academy well at Annapolis obtained flowing water from the Magothy at a depth between 180 and 220 feet, but as the supply was not sufficient the well was sunk deeper.

In New Jersey considerable artesian water has been obtained from the greensand deposits of the Upper Cretaceous. In Prince George's County no artesian wells are known in which the supply of water is obtained from the Matawan or Monmouth deposits. These are in general more porous than those of the Magothy or Potomac forma-

tions and contain fewer clay bands, so that the water passes more readily to lower levels.

Waters of the Eocene Formations.—The character of the Eocene beds is in the main similar to that of the Upper Cretaceous. More clay members are present, however, and consequently conditions for flowing wells are more favorable. The water is almost everywhere heavily charged with iron, and sulphur is also present in places. In this county no flowing wells obtain their supply of water from Eocene strata, but in the adjoining counties, particularly along the Bay shore of Anne Arundel County, many flowing wells obtain moderate flows of fairly good water from horizons within both the Aquia and Nanjemoy formations.

Waters of the Miocene Formations.—In the southern counties of the State, particularly in Calvert and St. Mary's, important water-bearing strata of Miocene age have been found to yield an abundant supply of excellent artesian water. Within Prince George's County, however, the Miocene strata lie so high that there is little head to the water contained in them, and flowing wells do not occur. Some shallow wells in the southern portion of the county probably derive their water supply from Calvert strata that in St. Mary's County yield artesian water

THE SOILS OF PRINCE GEORGE'S COUNTY

BY

JAY A. BONSTEEL.

Introductory.

The relationship existing between the geology and the soils of any given area constitutes an important phase of the agricultural investigation of the region. The influence exerted by the geology on the soils is of great importance in the theoretical consideration of the origin of the soils and of practical importance in determining the area, the characteristics, and the resources of each particular soil type. All of the geological formations of the world have been divided and sub-divided into formations and groups of formations in accordance with their sequence of deposition, as indicated by their relative positions with regard to one another and in accordance with the stage of development of fossil life forms that have been buried in the different layers.

Since the basis of geological classification is one of age and of place relationships, while the fundamental principle of soil classification depends upon differences of soil texture, a given geological formation may give rise to two or more soil types. On the other hand, since the mineral composition and rock texture of different geological formations may closely resemble each other though their ages differ, so a single soil formation may be derived from two or more geological formations. Physiographic relations to stream drainage and to climate are also considered in the classification of the soils.

Prince George's County lies almost wholly within the Coastal Plain region of the State, though its extreme northern boundary slightly overlaps upon the Piedmont Plateau. Only a single soil type, the Cecil mica loam, is derived from the crystalline rocks of

the latter region; all the other soils of the county are derived from the unconsolidated sediments belonging to the Mesozoic and Cenozoic portions of the geological column.

The Soil Types.

The area of the several soil types occurring in Prince George's County are given in the following table:

Areas of Different Soils.

Soil	Acres	Per Cent.
Leonardtown loam	45,770	14 9
Susquehanna gravel	41,470	13 5
Windsor Sand	37,420	12.2
Westphalia sand	36,190	11.8
Meadow	30,870	10 0
Norfolk sand	23,630	7.7
Collington sandy loam	23,260	7 6
Susquehanna clay	22,360	7.0
Susquehanna clay loam	16,850	5.5
Norfolk loam	9,660	3.1
Sassafras loam	9,090	3.0
Sassafras sandy loam	4,830	1.6
Leonardtown gravelly loam	3,710	1.2
Elkton clay	1,450	0.5
Cecil mica loam	600	0 2
Total	307,160	.....

THE COLLINGTON SANDY LOAM.

The Collington sandy loam comprises an area of nearly 36 square miles lying entirely within the "Forest of Prince George." The

surface is gently rolling or nearly flat and lies at an elevation of from 80 to 160 feet above sea level. The original forest growth has been removed over this soil area, and with a very few exceptions the land is under a high state of cultivation. The usual staple crops of corn, wheat, and tobacco are cultivated upon this soil type. Wheat produces about 10 bushels and corn from 25 to 35 bushels per acre, while the tobacco raised is of good quality, yielding from 700 to over 1,000 pounds per acre.

The Collington sand is derived through the natural process of weathering from the Aquia formation of the Eocene period. The material constituting this formation consists of the mineral glauconite, a complex silicate of the bases potassium, calcium, magnesium, and ferrous iron, containing also some phosphoric acid. It is mixed with medium to coarse grained quartz sand. This material still remains unconsolidated, except for a narrow band of siliceous rock only a few feet in thickness, which has very little influence upon the soil of the region.

The Collington sandy loam as a soil type has been directly derived from the outcroppings of this greensand. Upon exposure to the weather the dark-green glauconitic material is affected chemically by the action of rain water and the impurities which it carries in solution. The quartz grains contained in the greensand are only slightly dissolved during the chemical reactions which follow. On the other hand the glauconite, which is a very complex and unstable silicate, is altered in its chemical composition. Salts of potassium, magnesium, calcium, and iron are formed, and these, being soluble to different degrees, are unequally leached away by the circulation of the soil waters. The iron salts, in particular, frequently accumulate in the form of pipes, tubes, and irregular concretions of hydrated carbonate of iron, binding together grains of quartz sand. These pipes are frequently filled with unweathered or partly weathered glauconite.

Glauconite, as is the case with the greater number of minerals, is a salt, but a very complex one, containing, as stated above, potassium, ferrous iron, calcium, and magnesium as bases, the bivalent elements replacing each other in somewhat indeterminate quantities. The

complex silicic acid is very weak as compared with the bases. Although the mineral itself, perhaps, does not possess a large solubility, in as far as it is soluble at all it will be dissociated and greatly hydrolized.[1] The result will be the formation of large quantities of hydrates of potassium, calcium, and magnesium, which will in turn be converted to the corresponding carbonates, or, more probably, hydrogen carbonates, better known as bicarbonates, through the absorption of and combination with the carbon dioxide contained in considerable quantities in the atmosphere of all soils.

The ferrous iron will also be largely converted into the hydrate by the hydrolytic action of the water. But it will be further acted upon by both the oxygen and carbon dioxide in the soil atmosphere, so that the final product which it yields will be a more or less highly carbonated ferric hydrate, and it is this material which forms the cement of the pipes described above. As the analyses show, this glauconitic material is unusually rich in potassium.

Analyses are given in the following table of a greensand marl obtained from an outcrop of the fresh material near Upper Marlboro, in Maryland, as well as of two soils and three subsoils. The method of analysis chosen was the official one of the Association of Official Agricultural Chemists—that is, the digestion in concentrated hydrochloric acid of specific gravity 1.115. This method was selected principally because it would enable the results obtained on these samples to be compared with those of other agricultural chemists, and probably it furnishes as clear an idea as any other method would of the agricultural values of the samples.

It may be said in general that the results of this chemical examination show the chief value of the greensand marls of Maryland to be due to the potash they contain, and which they slowly release as they dissolve and break down in the process of weathering. To a much less extent probably are they of value for their content of lime and phosphoric acid. In this latter respect they do not compare favorably with the similar marl deposits of New Jersey and some other regions, which, while valuable for the potash they contain, are more so on account of the very large content of phosphoric acid and

[1]For a general discussion of this subject the reader is referred to Bull. 17, Division of Soils, U. S. Department of Agriculture, 1901.

soluble lime. It is probable that the New Jersey greensand marls would on the average have a phosphoric acid content fifty times as great as the corresponding marls from Maryland. It is, therefore, very questionable whether many of the greensand marls of Maryland can have any important economic future as a fertilizer when compared with other products now on the market.

CHEMICAL ANALYSES OF GREENSAND AND COLLINGTON SANDY LOAM.

Constituent.	6034.* Per cent.	5454.† Per cent.	5455.‡ Per cent.	5456.§ Per cent.	5459.° Per cent.	5460.°° Per cent.
Potash (K_2O)	2.565	0 858	0.888	0.445	0.910	0.376
Soda (Na_2O)	.391	.980	.718	2.401	.418	.692
Lime (CaO)	.170	.140	.155	.110	.155	.210
Magnesia (MgO)	.740	.136	.396	.474	.185	.336
Manganese oxide (MnO)	.....	.037	.030	.....	.035	.037
Iron (Fe_2O_3)	16.306	9.488	4.011	9.067	3.632	6.248
Alumina (Al_2O_3)	.130	4.011	2.448	4.097	2.856	4.742
Phosphoric acid (P_2O_5)	.065	.088	.054	.104	.053	.076
Sulphuric acid (SO_3)	.012	.132	.116	.096	.110	.056
Insoluble	74.049	.....	.....	.....	.....	.....
Moisture	2.130	.....	.....	.....	.....	.....
Volatile organic matter	1.975	.....	.....	.....	.....	.....

*Greensand deposit. Upper Marlboro, Md.
†Subsoil, 8 to 36 inches, Oak Grove, Md.
‡Soil, 0 to 7 inches, Mullikin, Md.
§Subsoil of 5455, 7 to 36 inches.
°Soil, 0 to 9 inches, Mullikin, Md.
°°Subsoil of 5459, 9 to 36 inches.

An inspection of the table will show that the soils and subsoils derived from glauconitic material are rich in potassium, as compared with agricultural soils in general, although a proportionally large amount of this element disappears in the weathering process during soil formation. On the other hand, neither the lime nor phosphoric-acid content of these soils is materially different from that of the original material and both are lower than is considered desirable for good soils. The indications of this examination are that these soils

are lacking in lime, phosphoric acid, and humus, and efforts to improve them in these respects are desirable.

In the field the results of the chemical processes of weathering are shown by nearly every soil boring taken within the area of the Collington sandy loam. The surface soil, which has a depth varying from 9 to 20 inches under different conditions of cultivation, consists of a loose, loamy, brown sand, usually containing considerable coarse sand and small amounts of intermediate grades of soil particles down to silt and clay. The loamy nature differs from that of ordinary soils in the fact that the rather coarse materials are bound together by much finer materials, which are sticky rather than plastic. Even this fine material when dry crumbles easily to the touch into a powdery brown mass. The immediate subsoil differs from the soil in texture and composition. The glauconite is passing through intermediate stages of weathering, and has been sufficiently transformed to constitute a sticky, claylike mass, in which dark-green specks of glauconite can still be distinguished. The partly weathered glauconite includes a considerable percentage of quartz sand within its mass. The hydration of the iron salts produces a yellowish or greenish-yellow color in the subsoil. Usually at a depth of 30 to 40 inches the greensand can be found in almost its original state of purity. It has been much less attacked by the processes of weathering than either the soil or the immediate subsoil. It still maintains a considerable supply of potash, phosphoric acid and lime—three plant foods commonly purchased at considerable expense in the form of commercial fertilizers. The presence of this plant food underneath the soil is manifested by the general productivity of the entire area of the Collington sandy loam.

In the Prince George's area this greensand marl, which occurs along the numerous stream cuttings and natural cliffs, has only been used to a slight extent as a source of fertilizer. In one case, it is said, its copious application over an already sandy soil produced a crop of wheat averaging 25 bushels per acre, and its effect was noticed in several succeeding crops. In other areas, both in the United States and foreign countries, the greensand marl has long been utilized as an inexpensive though effective medium for restoring impoverished

soils. Its application upon heavy loam or clay lands should be particularly beneficial, since the sandy nature of this marl would improve the texture of the soil while its chemical elements supplied essential plant foods.

The Collington sandy loam is justly recognized as a good soil for general farming operations, but its adaptability to special crops is only partly realized. It is an area excellently adapted to market gardening and medium and late truck crops. It produces fruits of excellent quality and its special adaptation to the production of nursery stock is already utilized. It should also furnish excellent crops for canning factory purposes.

The present system of general farming practiced on this soil type should give place to a much more specialized type of agriculture, accompanied by a decrease in the average size of the land holdings and by much greater profits per acre.

The following table gives mechanical analyses of typical samples of soils and subsoils of Collington sandy loam:

MECHANICAL ANALYSES OF COLLINGTON SANDY LOAM.

No.	Locality.	Description.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5457	1½ miles SW. of Woodmoor, Md.	Medium, loose green sand, 0 to 11 inches.	1.70	Tr.	4.52	10.34	59.18	10.10	7.22	5.10
5459	Mullikin, Md...	Fine, mealy sand, 0 to 9 inches.	4.78	0.00	1.10	4.24	33.94	11.14	36.52	8.08
5451	Oakgrove, Md...	Loose, fine greenish sand, 0 to 7 inches.	1.92	Tr.	1.94	9.04	50.12	16.76	9.54	10.74
5455	1½ miles SE. of Mullikin, Md..	Fine glauconite sand, 0 to 7 inches.	4.42	0.00	2.38	6.16	54.64	16.96	4.22	10.96
5458	Subsoil of 5457..	Medium glauconite sand, sticky, 11 to 36 inches.	1.86	Tr.	6.86	16.44	48.50	5.38	8.40	12.26
5460	Subsoil of 5459..	Fine to medium sand, 9 to 36 inches.	2.30	0.00	Tr.	5.18	33.62	17.10	20.70	20.68
5452	Subsoil of 5451..	Glauconite sand, sticky, 7 to 36 inches.	2.92	0.00	2.84	6.76	46.22	14.72	6.78	19.92
5456	Subsoil of 5455..	Heavy sand, rather sticky, 7 to 36 inches.	2.82	0.00	2.44	5.14	50.26	13.52	4.92	21.16

THE NORFOLK SAND.

The Norfolk sand occupies a total area of 23,630 acres in Prince George's County. It covers low-lying, flat-topped terraces along the larger stream courses, and caps the highest hills in the northern central portion of the county. It is derived from various sandy strata found in the Coastal Plain portion of Maryland, either by the direct weathering of the outcrops or by stream erosion, transportation, and redeposition in other localities.

The accompanying analyses exhibit the sandy nature of this soil:

MECHANICAL ANALYSES OF NORFOLK SAND.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5487	2 miles NW. of Priest Bridge.	Coarse sand, truck soil, 0 to 9 inches.	0.01	0.80	0.00	7.56	34.78	37.86	9.60	6.34	2.33
5485	2 miles NE. of Bowie.	Medium fine yellow sand, 0 to 10 inches.	.01	1.90	2.10	11.78	24.54	32.12	7.16	13.32	5.79
5489	¼ mile N. of Hyattsville.	Brown sand, 0 to 7 inches.	.01	3.00	9.08	23.62	19.50	13.76	7.16	16.60	6.03
5488	Subsoil of 5487.	Coarse yellow sand, 9 to 40 inches.	.01	0.60	0.00	7.56	42.64	32.16	8.18	6.40	2.25
5486	Subsoil of 5485.	Medium sand, 10 to 30 inches.	.01	1.90	Tr.	8.98	22.56	31.50	6.42	15.72	12.03
5490	Subsoil of 5489.	Loamy red sand, 7 to 36 inches.	.03	2.56	8.50	22.64	13.16	18.56	5.18	16.00	12.87

The uncleared areas of Norfolk sand are occupied by forest growths of pitch pine and several varieties of oak. A large portion of the area occupied by this soil type is cleared and utilized in general farming or truck growing.

The terrace areas are flat-topped or only gently inclined, while those areas derived from the outcrop of older strata are rolling or gently inclined.

The soil consists of a medium to coarse orange or yellow sand, having a depth of about 10 inches. It is underlain by a coarse sandy subsoil which usually becomes loamy at a depth of about 3 feet. The loose, open character of this soil prevents it from maintaining a large water supply, and thus precludes the successful production of such crops as require a long growing season.

This soil is especially adapted to the production of early truck crops, which can be forced to an early maturity and prepared for a profitable market. This soil is largely utilized for trucking and market gardening along the Atlantic seaboard. Early strawberries, melons, potatoes, and sweet potatoes can all be raised with profit, while small crops of high-grade tobacco can also be produced.

The soil requires careful treatment under highly specialized conditions of farm practice. It requires the incorporation of large amounts of organic matter in order to produce the best results. The plowing under of leguminous crops and the addition of stable manure improve the texture of the soil.

THE WESTPHALIA SAND.

The Westphalia sand occupies the gently sloping valley walls and the low, rolling hilly areas of eastern Prince George's County. The type is derived from the weathering of the surface outcrops of several sandy geological formations. Small areas of Westphalia sand near Buena Vista are derived from the loamy micaceous sands of the Matawan, but the greater number of the areas are derived from the clayey, somewhat glauconitic sands of the Nanjemoy formation. In the southwestern part of the county the sandier upper portions of the Calvert also give rise to Westphalia sand areas. These lie as low hills along the slope to the Patuxent River, and the soil type here attains its greatest agricultural value.

The natural forest growth of this soil includes oak, sycamore, tulip, and chestnut. No large forest areas exist, but scattered clumps of trees abound.

The soil consists of a fine sand or slightly loamy sand, yellow in color and friable and powdery when dry, but slightly sticky and easily compacted when wet. It is underlain at a depth of 9 to 16 inches by a loamy, fine-grained sand, slightly more cohesive and sticky. This is sometimes succeeded by loose gray sand, but not universally.

The accompanying table shows the texture of this type:

MECHANICAL ANALYSES OF WESTPHALIA SAND.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
5475	1 mile S. of Marlboro.	Very fine, mealy yellow sand 0 to 10 inches.	0.01	2.44	0.00	Tr.	0.70	14.42	56.04	17.00	8.29
5477	2 miles N. of Marlboro.	Fine, mealy brownish sand, 0 to 10 inches.	.01	2.52	Tr.	1.50	1.94	17.22	44.40	23.20	9.21
5479	2 miles S. of Aquasco.	Fine, mealy yellow sand, 0 to 12 inches.	.01	3.14	.00	.00	2.82	24.98	34.74	19.80	13.49
5476	Subsoil of 5475	Very fine mealy sand, 10 to 30 inches.	.01	1.92	.00	.00	Tr.	7.18	65.50	20.22	5.13
5480	Subsoil of 5479	Fine, sticky sand, 12 to 36 inches.	.01	2.86	.00	.00	1.14	10.08	48.72	25.60	10.67
5478	Subsoil of 5477	Fine to sticky sand, 10 to 30 inches.	.01	2.14	Tr.	2.22	2.56	22.23	41.38	15.32	14.63

The Westphalia sand is finer-grained, less porous, and less friable than the Norfolk sand. It is well adapted to the production of the Maryland type of export tobacco, especially where its surface is level or only gently sloping. On the steeper slopes it is liable to be washed destructively. It is also a good producer of Irish potatoes and corn.

Though somewhat loamy, its water-holding capacity is not sufficient to constitute it a desirable grass or grain soil. These crops are cultivated in the regular crop rotation, but without securing profitable yields. Peaches, small fruits, strawberries, and melons could be raised to advantage on this soil type, and its physical properties fit it for the production of these and later truck crops. It could not compete with the Norfolk sand in the production of early truck.

The smaller areas of Westphalia sand, especially those lying on the steeper slopes, are not well adapted to agricultural purposes. The removal of the surface soil is so rapid that underlying material is not prepared for crop production by weathering with enough rapidity to maintain annual crops. Such areas should become orchard lands or should be reforested.

THE WINDSOR SAND.

This type of soil, which is found in many other localities along the Atlantic Coast, occupies an area of about 58 square miles, chiefly in the upland area of central and southern Prince George's County. It is usually found along the gently sloping valleys of streams or where the headwaters of two drainage systems approach each other. The surface is thus gently sloping or more steeply inclined, with the change of circumstances of stream erosion.

This soil in its natural condition is the one most preferred by the pitch pine, and the extensive forests of this tree found on the Windsor sand have led to its being called "pine barrens" in some localities. This name is misleading, for although unsuited to the production of grain and grass crops, the Windsor sand constitutes a type of soil adapted to early truck crops, to fine early peaches, and, under favorable climatic conditions, to fine grades of tobacco.

The Windsor sand consists of a medium to coarse sandy soil that contains about 10 per cent of fine gravel. The soil is loose and friable and very unretentive of moisture. It reaches to the depth of about 8 or 10 inches and is underlain by a coarse sandy subsoil, which differs from the soil chiefly in its smaller content of organic matter. The depth of the subsoil depends largely upon the location of the area. The higher-lying, flatter areas have the deeper and sandier sub-

soils, and are more typically developed. The areas along the stream slopes, being subject to wash from above and also themselves arising from local soil creep and migration, are more irregular in texture and are usually of a less depth.

The Windsor sand also occurs along the Patuxent River and some of the other larger streams as a low-lying flat-topped stream terrace. The soil texture is the same as that of the upland areas, and the vegetation and crop value are closely similar, but the position near tide level gives an advantage to the areas in two ways. In the first place, the products of the area are nearer to water transportation. In the second place, many of the areas are so situated that whenever it becomes desirable the waters of upland streams can be turned upon them for irrigation purposes.

The Windsor sand produces a good grade of tobacco in several regions where it occurs, but it is uncertain, from the fact that its loose, porous character makes it particularly hard to manage during a protracted drought. The same difficulty is encountered in the production of truck crops. For this reason an intensive system of cultivation is required, including the incorporation of considerable amounts of organic matter with the soil to form a spongy, moisture-holding mass, as well as to furnish needed plant foods. When, in addition, it is possible to irrigate, and the value of crops produced is sufficient to warrant it, the water supply can be controlled and a crop produced every year instead of once in two or three years. As yet the conditions are not such as would warrant so expensive a treatment in the Prince George's areas, but many of them can be irrigated when it becomes desirable to do so.

The texture of this soil and subsoil is shown by the accompanying table.

THE SUSQUEHANNA GRAVEL.

Scattered areas and long, narrow bands of distinctly stony or gravelly soil have been indicated as a special type. The different areas are usually found along steeply inclined slopes or near stream divides. In both cases active stream erosion has removed the surface

covering, consisting of other soils, and the heavy gravel bands which underlie several of the upland soil types are thus exposed.

The natural timber growth of these gravelly areas consists of chestnut, pine, and oak, while the cultivated crops are usually the same as those found on better soils. Where a single narrow gravel band crosses a cultivated field no difference is made in the adaptation of

MECHANICAL ANALYSES OF WINDSOR SAND.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
5511	3 miles NE. of Bowie.	Coarse sand, 0 to 9 inches.	0.01	0.72	11.92	40.36	21.50	11.38	2.86	7.48	3.09
5509	1 mile S. of Queen Anne.	Coarse sand and gravel, 0 to 8 inches.	.01	.94	9.18	23.36	19.10	17.42	7.36	15.28	4.57
5512	Subsoil of 5511.	Coarse sand and gravel, 9 to 24 inches.	.01	1.12	11.36	35.38	21.90	13.36	4.82	7.68	3.65
5510	Subsoil of 5509.	Coarse sand and gravel, 8 to 30 inches.	.01	1.54	9.30	24.76	21.42	15.18	5.06	14.68	7.73

crop to this exceptionally gravelly condition, although the yield of the crop is invariably much less than upon the other soil. Where the larger areas are found, the Susquehanna gravel if cleared should be reforested, not only because of its small value as farm land, but also to prevent further washing and destruction of adjoining areas of more valuable soil.

The Susquehanna gravel consists of 30 to 60 per cent. of coarse gravel mixed with sand and loam. It is underlain by various subsoils, usually loamy or sandy. In addition to presenting great difficulties in the way of cultivation, it is unsuited both by texture and attitude to the production of ordinary farm crops. Similar soils in

other regions have proved valuable for the production of grapes, but reforestation is recommended for the majority of the areas found in Prince George's County.

THE LEONARDTOWN LOAM.

The Leonardtown loam comprises a total area of about 70 square miles. It lies entirely within the upland portion of the county, occupying the highest levels in the southern part of the county and covering the gentle slopes along the border of the Piedmont Plateau. In the southern part of the county the surface of this soil type is flat or only gently rolling, while in the northern part it occurs somewhat less typically developed as a rolling or sloping surface. In all cases this soil type is bordered by areas of stony or gravelly soil. In other portions of the Coastal Plain this soil was originally occupied by extensive forests of white oak. When this timber is removed the areas occupied by the Leonardtown loam usually grow up to pitch pine unless cultivated. A considerable portion of this soil type in the southern part of Prince George's County is still covered by white-oak forest, but in the northern part of the county it is almost entirely under cultivation.

The soil itself consists of a yellow silty loam having an average depth of about 10 inches. It is underlain by a heavier yellow loam, which usually grades into a mottled loam at a depth of from 28 to 32 inches. At this depth the subsoil becomes brittle and crumbly, and a close examination shows that it consists of thin layers or lenses of clayey loam, which are separated from one another by thin seams or pockets of sand. Where the entire thickness of the soil formation does not exceed 5 or 6 feet the subsoil may also contain some fine gravel. Along the borders of this soil type the sand and gravel become more prominent as the soil becomes thinner, and the Leonardtown loam grades off into more stony or gravelly types. The entire area of the Leonardtown loam is underlain at varying depths by a bed of coarse gravel mingled with sand, which reaches the surface along the margins of stream valleys. This gravel and sand give rise to another type of soil, elsewhere described, and also play an important part in the natural underdrainage of the Leonardtown loam.

The mechanical analyses of this soil are shown in the accompanying table.

The Leonardtown loam constitutes one of the heaviest types of soil cultivated in Prince George's County. It is silty rather than clayey

MECHANICAL ANALYSES OF LEONARDTOWN LOAM.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5467	2¼ miles NW. of Muirkirk.	Yellow silty loam, 0 to 11 inches.	0.01	2.78	0.96	10.92	9.08	5.86	3.04	51.00	16.69
5471	Fort Foote....	Loam, 0 to 12 inches.	.01	3.30	.00	Tr.	1.32	3.58	12.86	61.44	17.47
5465	1 mile S. of Bryant's Point.	Yellow loam, 0 to 7 inches.	.01	2.76	.00	Tr.	4.16	12.70	15.28	43.36	21.35
5469	1 mile SE. of Oxon.	Yellow silty loam, 0 to 9 inches.	.01	3.30	.00	1.04	1.18	4.42	4.56	61.72	21.93
5468	Subsoil of 5467	Heavy mottled loam, 11 to 36 inches.	.01	2.98	Tr.	11.38	9.30	5.96	10.42	40.42	19.99
5466	Subsoil of 5465	Mottled loam, 7 to 24 inches.	.01	2 50	.00	Tr.	3.74	13.16	11.98	41.58	26.19
5472	Subsoil of 5471	Heavy loam, 12 to 36 inches.	.01	3.22	.00	.00	1.04	3.46	4.78	56.38	28.37
5470	Subsoil of 5469	Mottled loam, 9 to 36 inches.	...	2.06	.00	Tr.	1.58	4.64	6.16	53.98	30.00

in its texture, while the subsoil, on account of its composition and peculiar lenticular structure, offers a resistance to the circulation of water comparable to that of a heavy clay soil. This type of soil is capable of retaining a considerable supply of moisture during the entire growing season. It is, therefore, adapted to the production of grass, wheat, and corn where general farming is practiced, and to cabbage, cucumbers, and late strawberries in the trucking areas.

This soil is only producing to its full capacity in the northern part of the county, where, through the use of green manures and lime, from 15 to 18 bushels of wheat per acre are frequently raised upon it. Elsewhere this soil type is generally lacking in organic matter. The Leonardtown loam should furnish an excellent soil upon which to introduce stock raising and dairying at points where market gardening can not be undertaken.

THE LEONARDTOWN GRAVELLY LOAM.

The Leonardtown gravelly loam occupies an area of about 6 square miles, occurring chiefly along the Montgomery County line. The surface is usually gently sloping and well drained, and this soil type is cultivated over the greater part of its area.

The original plant growth on the Leonardtown gravelly loam has been quite generally removed, but the areas now in forest show a second growth of oak and pine in about equal quantities. This soil is farmed to corn, wheat, and grass. It is more typically a corn soil than a wheat or grass soil, though these crops are produced to a fair advantage in the regular rotation.

The soil consists of a gravelly loam, containing from 15 to 30 per cent of fine and medium gravel mingled with some sand and larger amounts of fine material. The soil usually extends to a depth of 9 inches, and is underlain by a more compact yellow loam, which also contains considerable amounts of sand and gravel. At a depth of about 30 inches the subsoil is underlain by a bed of gravel and sand usually several feet in thickness.

The soil thus constituted forms an intermediate grade between the heavy, grain-producing soils and the light tobacco and truck soils. It is thus adapted to a variety of crops. At present it is used for general farming. In addition to the corn, wheat, and grass now raised, the Leonardtown gravelly loam is capable of producing good crops of tomatoes, peas, sugar corn, and similar crops in demand for canning purposes. It requires careful farming and a more general use of stable and green manure to secure the best results from this type of soil.

THE SASSAFRAS LOAM.

The Sassafras loam covers an area of about 14 square miles. It is found in flat-topped terraces along the Potomac and Patuxent rivers and their major tributaries. It is distinctly a terrace formation, occurring here and elsewhere in Maryland as one of the stages of the Columbia group of Pleistocene age. It is essentially flat-topped or gently sloping, and the different areas are often widely separated from one another by areas of soil derived from underlying and older geological formations. The Sassafras loam terraces are underlain at a depth of from 4 to 5 feet by a considerable layer of medium-sized gravel, which generally reaches the surface along their frontal slopes in the shape of Susquehanna gravel.

The Sassafras loam is occupied by areas of cleared and well-cultivated fields, suited to general farming and the raising of wheat, corn, and grass in greater quantities than the general average of the county. This soil is found in several areas within the Coastal Plain of Maryland, and it has been proved to be of great agricultural value in all these regions. Besides the common crops already mentioned peaches, pears, asparagus, late melons, late strawberries, tomatoes, and cucumbers are adapted to this soil.

The soil itself consists of a brown or deep-yellow loam, having an average depth of about 9 inches. It is uniformly underlain by a heavy yellow loam subsoil from 3 to 10 feet thick, which in turn rests upon an underlying gravel bed. The soil is capable of maintaining a good supply of moisture, and unless exposed to exceptional conditions of rain wash it is easily maintained in a good condition of productivity. It forms one of the most desirable types of soils for general farming operations, but does not produce tobacco or early truck crops to advantage. The accompanying analyses show the texture of this soil to differ little from the Leonardtown loam, but in the field they appear quite different:

THE SASSAFRAS SANDY LOAM.

The Sassafras sandy loam is developed over considerable areas along the second bottoms of the main river courses at an elevation of

from 60 to 90 feet above tide. The greater part of the area of this soil type found in Prince George's County occurs in such a position, but several small areas occur in the low uplands of the northern central part of the county at an elevation of about 180 feet. In both cases the surface of the formation is nearly level and so situated as

MECHANICAL ANALYSES OF SASSAFRAS LOAM.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5491	¼ mile S. of Queen Anne.	Silty loam, 0 to 12 inches.	0.01	2.48	Tr.	3.08	3.64	9.76	21.50	50.40	8.33
5495	3 miles S. of Piscataway.	Brown loam, 0 to 8 inches.	.01	2.92	0.52	1.18	1.68	12.66	7.94	61.88	10.91
5493	2½ miles N. of Bowie.	Yellow loam, 0 to 12 inches.	.01	3.44	.00	1.36	2.74	8.46	6.38	65.12	11.53
5494	Subsoil of 5493.	Heavy yellow loam, 12 to 36 inches.	.01	2.74	.00	1.46	3.84	12.36	9.78	52.08	17.97
5496	Subsoil of 5495.	Yellow loam, 8 to 36 inches.	.01	3.16	.30	.50	.64	8.10	14.56	49.72	21.83
5492	Subsoil of 5491.	Heavy yellow loam, 12 to 36 inches.	.01	4.06	.00	3.16	2.70	4.62	7.88	50.98	26.33

to be well drained and in good condition for agricultural purposes. Almost the entire area of the Sassafras sandy loam is under cultivation to general farm crops. Corn, wheat, and grass—particularly clover—produce well upon this soil. Good crops of Irish potatoes and medium crops of tobacco can be raised upon it.

This soil type owes its origin to the deposition of sedimentary materials in late Pleistocene time. The soil itself consists of a brown sandy loam of medium to fine-grained texture. It is easy to cultivate, and responds well to careful treatment. It has an average depth of about 10 inches. The soil proper is underlain by a slightly

sandy or rather heavy yellow loam, usually more than 5 feet in depth. While not so retentive of moisture as heavier types of soil, the Sassafras sandy loam is easily cultivated and its manipulation is perhaps better understood than that of the heavier soils. It is capable of producing a wider range of crops than it now supports. Green peas, sugar corn, and peaches are cultivated with success upon this soil in

MECHANICAL ANALYSES OF SASSAFRAS SANDY LOAM.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5499	2¼ miles NE. of Hyattsville.	Brown sandy loam, 0 to 8 inches.	0.23	3.56	4.38	13.02	9.96	11.10	6.96	24.76	17.08
5497	1 mile SW. of Collington.	Fine sandy loam, 0 to 9 inches.	.13	1.10	....	.....	2.76	14.30	13.42	43.90	24.27
5500	Subsoil of 5499.	Micaceous yellow loam, 8 to 30 inches.	.23	.84	6.70	12.98	9.56	9.42	6.16	27.72	23.38
5498	Subsoil of 5497.	Heavy yellow loam, 9 to 36 inches.	.14	.32	...	.....	1.60	13.66	4.88	48.74	26.61

other localities. The texture of its soil and subsoil is exhibited by the accompanying analyses.

THE NORFOLK LOAM.

The Norfolk loam occupies about 15 square miles, chiefly in the "Forest of Prince George." It occurs upon the uplands along the western and main branches of the Patuxtent River. The surface of the soil is rolling or hilly. It rarely descends below an altitude of 100 feet, and only in a few cases rises above 160 feet.

Almost the entire area of the Norfolk loam has been under cultivation since the early settlement of the county. The original forest was long ago removed and little second growth has been allowed to spring up. The fact that this part of the county is referred to as the "Forest of Prince George" would indicate that it was originally heavily timbered.

The Norfolk loam consists of a very fine sandy loam soil, having a depth of from 12 to 20 inches. The subsoil consists of a reddish, sticky loam, commonly considered a clay throughout the region. This is underlain in turn by a fine, mealy gray sand at a depth that varies from 32 inches to 5 or 6 feet from the surface.

The rolling character of the area occupied by this soil type gives rise to considerable variation in the texture of soil within single fields. Upon level or slightly inclined hilltops the sandy soil attains its greatest thickness and the gray sand, which constitutes the deepest subsoil, rarely reaches within 40 inches of the surface. Where the country is more rolling the surface sandy loam is thinner, and on the steeper slopes the sticky subsoil is barely covered by a thin layer of sandy loam. Frequently the gray sand reaches the surface lower down the slope and becomes stained to a light yellow color upon exposure to the atmosphere.

The small streams which have their headwaters in this area are continually transporting small amounts of the sand and sandy loam down their courses. This material, together with the outcroppings of gray and yellow sand along the hill slopes, has been mapped as a separate soil type. The Norfolk loam constitutes one of the soil types best adapted to the production of the Maryland pipe-smoking tobacco. For two hundred years this tobacco has been exported from southern Maryland, and the Norfolk loam, in Prince George's County and adjoining areas, has produced the best grades of this tobacco from the beginning to the present time. From 750 to 900 pounds of tobacco are produced to the acre. Under weather conditions favorable to the maturing and curing of the crop a bright "colory" leaf is produced, which is noted in the foreign market for its free-burning qualities.

The tobacco crop matures in about eighty or ninety days from the time it is transplanted into the field. It is cut, removed to the barn, and cured by natural processes without the intervention of artificial heat. The value of the crop is therefore dependent upon the weather conditions not only during its growth, but also throughout the long process of curing and preparation for market. A more uniform grade of tobacco has been produced by a few growers through the use of open fires in the tobacco barns. A few attempts have also been made at flue curing, but no definite results have yet been reached.

Corn, wheat, and grass are also produced upon the Norfolk loam. Wheat yields from 7 to 15 bushels, corn from 20 to 35 bushels, and hay from three-fourths of a ton to 1½ tons per acre. Some difficulty has been experienced in recent years in the production of clover. Cattle and sheep raising are carried on to some extent, but the uncertainty of the grass crop and the lack of practical experience in dairying have largely prevented the introduction of these desirable

MECHANICAL ANALYSES OF NORFOLK LOAM.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
5481	2 miles NE. of Leeland.	Fine sandy loam, 0 to 10 inches.	0.01	3.10	....	0.44	0.46	16.60	25.50	45.08	7.35
5483	2 miles N. of Upper Marlboro.	Fine sandy loam, 0 to 8 inches.	.01	2.08	.....	.....	1.18	30.74	41.82	13.22	10.41
5484	Subsoil of 5483.	Fine to medium sand, 8 to 36 inches.	.01	1.84	....	....	1.12	37.64	40.28	12.48	6.17
5482	Subsoil of 5481.	Heavy yellow loam, 10 to 32 inches.	.01	2.46	...	.....	Tr.	12.18	28.94	34.72	20.25

industries. The Norfolk loam, though exhibiting some differences in character over small areas, presents a constant type of soil adapted to the production of Maryland tobacco, and gives fair returns in general farming operations.

The soil and subsoil in this area are of a somewhat finer-grained texture than elsewhere in southern Maryland.

THE SUSQUEHANNA CLAY.

The Susquehanna clay covers more than 35 square miles of territory, lying along the main railroad lines connecting Washington and Baltimore. The greater part of the area remains uncultivated,

and is widely known on account of the vivid red and purple coloring of the subsoil. The peculiar properties of this subsoil have formed the subject of extended chemical and physical research. This soil type occupies steep valley walls, irregular hills, and stream bottoms alike. It is usually deeply gullied by small stream courses, and frequently bears no vegetation whatever. Where the natural processes of weathering have produced a shallow soil, a sparse and scattering growth of oak and pine is found.

The scanty soil covering in this area consists of 4 to 5 inches of a yellow clay loam. It is underlain by a stiff, plastic mottled clay, which is red, gray, or purple in color. This clay has been used extensively for the manufacture of brick, sewer pipe, and drain tile. The very properties which adapt it for this purpose make it unsuitable for cultivation.

The numerous mechanical analyses that have been made of this soil show that it differs but slightly in texture from the rich and fertile clays found in the limestone areas.[1]

It seems probable that the structure of this soil plays a more important part in the determination of its character than is the case with most soils. The fine particles which make up the greater percentage seem to be so evenly distributed that whatever moisture penetrates it is distributed evenly through a great number of very minute pores. The circulation of soil moisture is thus impeded, and while a large supply of water is maintained, it is so immovably held as to be of little use to growing crops.

The Susquehanna clay, where it is exposed at the surface with no covering of any other material, produces very little vegetation of any value. The scattered timber found upon this type is cut for railroad ties or for the production of charcoal. The few cultivated areas found upon the Susquehanna clay are not successfully farmed. In every known case where crops are produced to advantage within the Susquehanna area the immediate soil is formed by Pleistocene or other extraneous material that covers the clay to a depth of 8 or 10 inches. Even when so covered the successful production of crops depends upon careful and skillful farm management. Certain por-

[1]Texture of Some Important Soil Formations, Bulletin 5, Division of Soils U. S. Department of Agriculture, 1896.

tions of the area fall within another soil type (Susquehanna clay loam), and these portions are distinguished from the Susquehanna clay by marked features of origin and soil texture.

That some remedy for the unproductive conditions of the Susquehanna clay can be devised is firmly believed. The present structure of the soil and subsoil must be changed by the application of substances which will tend to flocculate the soil particles. In this manner the circulation of the soil moisture and the soil atmosphere should be facilitated and the stores of plant food, which have been shown by chemical analysis to exist in this soil, should be made available. Lime is one of the substances that produces such a flocculating effect upon puddled soils, and it not only improves the soil texture, but also aids in the chemical reactions necessary to make available the reserve supplies of plant food. It also acts directly as a plant food itself. Lime has already been used upon a soil formed by a surface layer of about 8 inches of Pleistocene loam overlying the Susquehanna clay subsoil. In this case good clover and fair grain crops have been produced. While the conditions differ from those pertaining to the most marked type of Susquehanna clay, the beneficial results would seem to indicate that the experiment of liming should be thoroughly tried upon that type. The transformation of the semibarren areas of Susquehanna clay to a productive soil is a result greatly to be desired, and thorough experimentation along scientific lines may yet accomplish it.

The accompanying table shows the texture of typical samples of Susquehanna clay.

THE SUSQUEHANNA CLAY LOAM.

Throughout the region occupied by the clays of the Potomac group there are found areas which, owing to the presence of lenses of sand or to the partial covering of Pleistocene material, do not fall within the limits of the Susquehanna clay. These areas, approximating an area of 26 square miles in Prince George's County, are irregularly scattered through the western part of the county. They are found on hilltops, on slopes, and in the valleys alike, and are frequently cleared, though considerable areas still support a forest growth of oak and pine.

The surface covering of the Susquehanna clay loam consists of about 10 inches of sand or sandy loam, though its depth may be somewhat less, but the distinguishing feature of this soil type is the heavy mottled clay subsoil, which is identical with the Susquehanna clay.

The surface covering of sandy loam, however, furnishes an easily tilled seed bed which is of sufficient depth to germinate seeds and nourish the young plants. The heavy clay subsoil, covered by this loose-textured soil, serves as a reservoir for maintaining a good moisture supply, and its imperviousness aids in the retention of plant foods, which would be leached readily from the soil alone. As a result this modification of the Susquehanna clay, by the intervention of other materials to form the soil, gives rise to a type adapted to general farming, and especially to grain and grass crops. This type of soil requires very careful farming. Lime is used to good advantage, and with its use some excellent clover crops have been produced.

MECHANICAL ANALYSES OF SUSQUEHANNA CLAY.
[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5503	¾ mile N. of Ardwick.	Yellow silty loam, 0 to 6 inches.	0.01	1.70	0.00	0.00	5.56	24.78	14.10	43.28	9.93
5501	1 mile N. of Agricultural College.	Clay, gravel, and iron crust forest land, 0 to 4 inches.	.01	4.70	9.38	12.90	5.36	8.56	7.42	16.16	35.71
5504	Subsoil of 5503.	Mottled clay, 6 to 36 inches.	.01	3.26	0.00	2.20	1.98	8.70	5.42	42.78	36.55
5502	Subsoil of 5501.	Mottled clay, 4 to 30 inches.	.01	4.90	1.20	2.62	2.16	11.68	19.16	21.12	36.55

The accompanying table gives the mechanical analyses of soils and subsoils of this type of soil:

THE ELKTON CLAY.

The Elkton clay occurs locally in several small areas adjacent to stream courses in the northern portion of the county. Its surface is low lying, usually flat, and rather poorly drained.

The soil consists of a brown or gray silty loam having an average depth of about 9 inches. It grades down into a heavy yellow loam which is underlain at about 28 inches by a mottled yellow and gray clay loam. On account of its low-lying position this soil is apt to be wet and difficult to cultivate. For the same reason the circulation of the soil moisture and the soil atmosphere is impeded.

In its natural state this soil is occupied by the sweet gum and willow oak. When cleared it affords good grazing, and is capable of pro-

MECHANICAL ANALYSES OF SUSQUEHANNA CLAY LOAM.

No	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
5505	2½ miles NW. of Piscataway.	Yellow loam, 0 to 9 inches.	0.01	3.52	Tr.	2.10	3.62	7.96	12.68	57.14	12.29
5507	1¼ miles S. of Agricultural College.	Brown loam, 0 to 6 inches.	.01	6.18	0.98	2.80	4.16	8.82	3.96	43.34	29.17
5506	Subsoil of 5505.	Mottled clay, 9 to 40 inches.	.01	3.72	....	Tr.	2.62	5.06	5.90	55.26	26.31

ducing excellent crops of wheat and grass. The small areas of this soil occurring in Prince George's County can be made to produce from 25 to 35 bushels of wheat or 2 tons of hay per acre by proper underdrainage and intelligent cultivation.

The texture of representative samples is shown in the accompanying table.

THE CECIL MICA LOAM.

The Cecil mica loam is a residual soil, occupying an area less than 1 square mile in extent in the extreme northern portion of Prince George's County and considerable areas in the District of Columbia. It is found along the steeper stream courses where overlying sedi-

mentary materials have been removed by erosion. The surface of this soil type is rolling or deeply sloping, and it usually descends to rocky, uncultivated areas along the streams. This soil has been derived from underlying crystalline rocks through the mechanical and chemical processes of weathering. The circulation of atmospheric water charged with various chemicals has broken down the minerals of which the rock was composed. The action of frost and

MECHANICAL ANALYSES OF ELKTON CLAY.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P. ct.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
5461	1¼ miles NW. of Marlboro.	Fine gray loam, 0 to 8 inches.	0.01	3.74	Tr.	1.56	1.24	7.90	33 08	41.54	9.73
5463	3 miles S. of McKendree.	Mealy gray loam, 0 to 10 inches.	.01	6.02	1.64	2.30	2.24	4.22	4.98	47.84	30.63
5462	Subsoil of 5461.	Heavy grayish clay, 8 to 36 inches.	.01	3.14	0.00	0.00	2.58	6.24	34.10	35.00	18.59
5464	Subsoil of 5463.	Sticky mottled clay, 10 to 36 inches.	.01	3.78	0.00	Tr.	.96	1.64	5.68	50.88	36.43

encroaching vegetation has further modified the composition and the texture of the surface material. In this way a soil has been formed which is composed of disintegrated and decomposed rock materials. Certain minerals have resisted this weathering process, and still survive in the soil in their original condition.

The soil of the Cecil mica loam consists of a friable yellow loam which contains considerable quantities of unweathered muscovite mica, existing in small flakes. When dry this soil is loose and almost sandy; when wet it feels slippery and greasy—a property due to the presence of a large quantity of polished mica scales. The subsoil, occurring at a depth of about 9 inches, is a reddish-yellow loam, which also contains a large proportion of mica flakes. This grades

down at various depths into partly decomposed crystalline rock. Both soil and subsoil contain broken fragments of quartz and undecomposed rock.

This soil, like most residual soils, contains fair supplies of most of the essential plant foods. Its texture is also favorable to the retention of moderate amounts of soil moisture. The Cecil mica loam is suitable for the production of corn, wheat, and grass, and is capable of attaining a high state of cultivation as a soil adapted to general farm crops.

The texture of the soil and subsoil is shown by the following mechanical analyses:

MECHANICAL ANALYSES OF CECIL MICA LOAM.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
5449	2 miles northwest of Laurel	Micaceous brown loam, 0 to 12 inches.	0.01	4.24	4.54	15.04	12.36	26.52	10.28	17.60	10.67
5450	Subsoil of 5449.	Micaceous reddish loam, 12 to 40 inches.	.01	4.50	4.72	11.24	10.56	25.08	7.24	19.02	18.43

THE MEADOW.

All soils in this area are classed as Meadow whose chief characteristics are a level, low-lying position and a poorly drained or semimarshy condition. Nearly all of the areas thus mapped are at times subject to overflow by flood waters, and over most of them an intermittent deposition of gravel, sand, and silt takes place at such times.

The meadows are largely forested by water birch, sycamore, sweet gum, and willow oak, interspersed with a rank vegetation of running vines and coarse grass. They are usually uncultivated, and are used only to furnish grazing during the drier portions of the year.

Over these areas the process of soil formation is still in progress, and the meadow areas constitute incomplete stream terraces which are not yet adapted to cultivation. Some portions of the meadow area mapped in Prince George's County could be transformed into agricultural lands by underdrainage or by inexpensive diking.

Filled Material.—This represents that part of the city of Washington where the surface has been elevated by bringing in material from other parts. On the islands bordering the Potomac the material has been pumped from the river and allowed to settle in still water. This is either a rich dark loam or sandy loam. It is almost entirely above flood level and is capable of producing large crops. Some of the trial gardens of the Department of Agriculture are located on this material.

Over Capitol Hill, in the northwest section of the city, and through Mt. Pleasant and the Soldiers' Home regions large areas have been graded down from 2 to 20 feet, but of this no account has been taken and the original types are shown on the map.

The Agricultural Conditions.

At the present time the land holdings of Prince George's County vary in size from 100 or 200 acres up to 1,000 acres or more in a single tract. The larger farms are worked under a tenant system, the tenants making payment either in cash or in farm products, under varying conditions of contract. Near the boundary of the District of Columbia many of the larger farms have been subdivided into small parcels and sold to persons desirous of engaging in market gardening. Upon these smaller tracts are produced radishes, lettuce, tomatoes, cucumbers, melons, green peas, sugar corn, and berries, which are transported to Washington by team and there either sold from market stalls or peddled from house to house. Upon these market-garden farms an intensive system of cultivation has been practiced in order to produce a steady supply of the various crops in season. The labor upon these small tracts is largely performed by the owner, the members of his family, and a few hired hands. Large amounts of lime, gas lime, and stable manure are

obtained from the city to maintain the fertility of the market-garden farms.

The trucking industry, which is carried on to some extent in northern Prince George's County, differs from market gardening in that larger tracts are cultivated under a single management and larger areas of single crops are produced, to be sold on commission in the various markets. The chief trucking crops of the county are green peas, strawberries, and sugar corn. To these should be added early Irish potatoes and sweet potatoes, which are also produced in connection with the general farming crops.

The trucking and market-gardening areas are confined to the northern and northwestern portions of the county. Tobacco, while not confined to any particular locality, is most successfully produced in the area known as the "Forest of Prince George," which extends from Bowie southward along the Patuxent to the extreme limits of the county. Of the general farm crops corn ranks next to tobacco in importance. Wheat is the only other grain produced extensively, though considerable areas of rye are sown, largely for the pasturage furnished, the grain entering as an incidental profit. The raising of cattle and sheep is being reintroduced into the county, although attended by some practical difficulties.

Upon those farms where tobacco is raised lime is little used, since its application injures the burning quality of the leaf. Commercial fertilizers, however, have been used in large quantities for many years to increase the production of tobacco and the grain crops. They have been considered a complete fertilizer in many cases, and too little attention has been paid to the restoration of organic matter to the soil. Recently leguminous crops in the form of cowpeas and crimson clover have been introduced and the system of agriculture improved through this means. The production of good forage crops can only be resumed by a more generous use of lime and the leguminous green manures. The cowpea seems better adapted to this end than any other leguminous crop. The restoration of the soils to conditions favoring grazing must necessarily be slow. Many of the farmers of the region recognize the desirability of raising more stock

and are seeking to enlarge their facilities by raising redtop and other grasses.

Among the soils of the county the Cecil mica loam is notable as the only residual soil. It occurs in many other areas along the Atlantic coast, and is usually cultivated to corn, wheat, grass, tomatoes, and orchard fruits. Under favorable conditions of season it is capable of producing 15 to 25 bushels of wheat, 45 to 60 bushels of corn, and 1 or 2 tons of hay per acre. It is not a heavy soil and therefore, while quickly responsive to applications of commercial fertilizers or stable manure, it requires frequent applications of fertilizer and careful farming to maintain the yields quoted.

The Elkton clay is a strong productive soil when properly drained, and with careful management is capable of producing 30 bushels of wheat or 2 tons of hay per acre. Liming and underdrainage are the chief requirements of this soil type.

The Leonardtown gravelly loam is better adapted to the production of peaches, pears, and other orchard fruits than to general farming. Its texture, location, and drainage fit it for the fruits named. The yield of wheat ranges from 15 to 18 bushels per acre; of corn, from 30 to 35 bushels.

The Sassafras sandy loam is one of the most valuable of Coastal Plain soils. In addition to its good texture it contains large stores of plant food, is well drained and possesses a level, easily tilled surface and usually an advantageous location with regard to transportation facilities. Its full capabilities as a general crop soil have not been reached in Prince George's County. With proper fertilization, including the use of stable manure and of green crops plowed under, the Sassafras sandy loam should produce 25 bushels of wheat, 50 to 60 bushels of corn, and 2 tons of hay per acre. It is also well adapted to the production of tomatoes, green peas, sugar corn, broom corn, cabbages, and cucumbers. It is not a typical early truck soil, but is capable of yielding good results when devoted to market gardening.

The Sassafras loam is found in many localities in the Atlantic Coastal Plain. It is uniformly a medium to heavy loam, capable of a high development as a general farming soil. In southwestern New

Jersey large areas of this soil produce 30 to 35 bushels of wheat, 45 to 60 bushels of corn, 8 to 9 tons of tomatoes, and 2 tons of hay per acre. It is the soil most preferred for stock raising and dairying, and possesses an average value of $50 to $65 per acre. On the Eastern Shore of Maryland extensive tracts of Sassafras loam are devoted to peach and pear orchards, while tomatoes, sugar corn, and green peas are raised for canning. The type there is valued at $35 to $60 per acre. In southern Maryland, including Prince George's County, a much smaller range of crops is cultivated on this type, though the climatic, soil, and market conditions are nearly identical in the three regions. The type is valued at only $12 to $25 per acre on the average in the county. It is thus seen that the opportunities for improvement in agricultural methods, for the introduction of new crops, for the development of new industries, and for the profitable investment of capital are many and great.

The Leonardtown loam constitutes the nearest approach among Maryland Coastal Plain soils to the heavy wheat and grass producing soils of limestone regions. In spite of its level surface and its advantages of drainage this type has been allowed to grow up to pine and oak forest to a considerable extent since the civil war. It is not adapted to the production of tobacco, and its capabilities in other directions have remained unknown or unappreciated. This soil type needs extensive applications of lime and green manures to make it highly productive. It should produce good crops of wheat, corn, and grass, and form the basis of dairying or stock-raising activities. It is the most extensive of the soil types in the county, and it can be bought for $1.50 to $5 per acre in the unimproved state or for $5 to $10 per acre improved, within a few miles of the District of Columbia line. Experiments in other areas have shown that proper management will make this soil produce from 15 to 20 bushels of wheat, from 35 to 50 bushels of corn, and from 1 ton to 1½ tons of hay per acre. The only means employed to secure these yields have been the application of lime and stable manure.

The Norfolk sand is a typical Atlantic Coast truck soil. It is a mealy, porous, warm sand, well drained and easily cultivated. In regions where trucking forms an important part of agriculture this

soil is sought out as best adapted to the production of watermelons, canteloupes, sweet potatoes, early Irish potatoes, strawberries, early tomatoes, early peas, peppers, eggplant, rhubarb, and even for cabbage and cauliflower, though the latter crops produce better yields on a heavier soil. The Norfolk sand in Prince George's County is well situated with regard to the markets of Baltimore, Washington, Pittsburg, and Philadelphia. Its climatic surroundings are favorable and the prices of land low. It should serve as the basis for a strong development of the truck industry in that county.

In texture the Westphalia sand is considerably finer grained than the Norfolk sand. On the other hand, it is not so distinctly loamy as the Sassafras sandy loam. It furnishes a type not so well adapted to the production of the early truck crops as to the raising of Irish potatoes, peaches, small fruits, and tomatoes. It is too sandy and porous to produce good yields of grain or grass, even when well fertilized. The more level, sheltered portions of this type in Prince George's County produce a fair yield of tobacco, while the steeper slopes are almost barren of any crop. The Westphalia sand is deficient in organic matter, and its texture and fertility can be considerably improved by the use of green and stable manure.

The Windsor sand is the loosest, most incoherent soil of the area. It does not retain sufficient moisture to mature the grain crops to advantage, but is well adapted to small fruits, such as raspberries and currants. Peach orchards located on this type are noted for their long life and for the size and beauty of the fruit produced.

The Susquehanna gravel exists only in narrow bands and small isolated areas. It is totally unfitted for most agricultural purposes and should remain in forest wherever possible. Grapes are raised on soils of similar texture in other regions, and the possibility of their culture on Susquehanna gravel should be experimentally determined.

The Norfolk loam has long occupied a commanding position in the production of the Maryland type of smoking tobacco. The hilltops throughout the "Forest of Prince George" are capped by this soil type, and the yield of tobacco and the prices commanded have been uniformly good in this region. In other areas of the type the same conditions hold. This type is commonly fertilized by the use of the

commercial products, though lately cowpeas have been employed in conjunction with the manufactured fertilizers. It is a fundamental principle with the tobacco growers that the application of lime on fields where the crop is to be raised injures the burning quality for which the tobacco is esteemed. In consequence, where tobacco is to form part of the crop rotation the other crops of the rotation suffer for lack of lime for the sake of the one year's growth of tobacco. The soils of this region all require lime for the production of grain and grass, and the present rotation, based on tobacco, does not permit the Norfolk loam to produce other crops to its best ability.

The Collington sandy loam is a peculiar soil derived from the decomposition in place of a greensand stratum. The resulting soil is a medium sandy loam underlain by a sticky, heavy sandy loam. The physical texture of this soil gives a warm seed bed, producing quick germination, and a good subsoil reservoir to maintain a water supply during the period of growth, while its chemical composition insures a good supply of potash salts, one of the most expensive plant foods when purchased as a fertilizer. The complete commercial fertilizer is not required on this soil so much as an application of phosphate rock, coupled with the production of cowpeas to supply nitrogen. These should be plowed under, in order to furnish additional organic matter. This soil type produces good crops of wheat, corn, tobacco, and grass, and is also adapted to Irish potatoes and fruit. In its sandier portions it raises good truck crops.

The Susquehanna clay constitutes one of the most intractable soils of the region. It is a sticky, plastic mass, difficult to cultivate, liable to excessive baking in dry times, and comparatively unproductive over a greater part of its area. Little has so far been accomplished toward the solution of the agricultural problem it presents. The extensive use of lime corrects its textural faults to some extent, and good crops of wheat and clover have been produced under this treatment.

The Susquehanna clay loam possesses a loose sandy or loamy soil capable of cultivation and of forming a natural mulch over the dense clay of the subsoil. As a consequence it forms a fair seed bed and yields medium crops of grain and grass.

The great variety of soils found in the county, the moderate climate and general healthfulness of the greater part of the county, its accessibility by rail and by water, all favor a greater specialization of agriculture and increased profits from the cultivation of the soil.

The location of Prince George's County is such that the further extension of the suburban residence section may be reasonably expected. Market gardening will also cause the further subdivision of the larger tracts of land, particularly those located near the District line. The area used in trucking operations is also increasing and should ultimately occupy the entire extent of the sandier types of soil. The canning industry should be introduced, for the climatic conditions and the great diversity of soil would permit of a continual succession of canning crops during the usual growing season.

THE CLIMATE OF PRINCE GEORGE'S COUNTY

By

WILLIAM H. ALEXANDER.

Introductory.

The principal object for which the Maryland State Weather Service was organized is to study thoroughly the climatic features of the different sections of Maryland, to ascertain as far as possible the effect of each of the controlling factors, and to publish the meteorological data available in sufficient detail to enable students to investigate the numerous problems of climate as related to hygiene, agriculture, and the mechanical arts, the solution of which is important for the welfare of the people. Pursuant to this plan, a General Sketch of the Climate of Maryland, by Mr. F. J. Walz, was published in Volume I of the Maryland Weather Service Reports, and a full account of the Weather and Climate of Baltimore, by Dr. Oliver L. Fassig, appeared in Volume II. Chapters have also been published on the climate of five counties in the State, namely Allegany, Calvert, Cecil, Garrett, and St. Mary's, and it is intended ultimately to cover every county in the State. Collected into one volume, these county reports will form an invaluable summary of meteorological information for the student.

The factors controlling climate.[1]

The climate of any region depends primarily upon the following chief factors:

Latitude; the physiographic features of the region, especially its position with reference to mountains or large bodies of water; to a

[1]The author has employed in his introductory paragraphs the general statements used by Mr. C. F. von Herrmann in earlier reports of the Survey.

minor degree on its topography, the slope of the surface, whether valley or mountain top, the nature of the soil and soil covering, and lastly, on the position of the region with reference to the prevailing path of storms.

The sun's power is greatest when the rays strike the earth's surface vertically, and the highest temperatures might be expected to occur in regions where the sun is overhead at noon, which can take place only within the tropics. The inclination of the earth axis 23½ degrees from the perpendicular to the plane of its orbit profoundly modifies this simple deduction by causing a variation in the length of the day as the pole is approached. During the summer of the northern hemisphere the length of the day increases rapidly from the equator toward the pole, and the increased duration of sunshine compensates largely for the greater inclination of the sun's rays. Maryland, lying between the parallels of 38° and 40° north Latitude, at the time of the summer solstice, June 21, has a day of nearly 15 hours' duration, and the soil and air are able to accumulate a large store of heat during the long summer day. The long winter nights which favor the loss of heat by outward radiation give a sharp contrast to the different seasons which is quite absent in polar or tropical latitudes. The factors which control climate act together in so intricate a manner that it is difficult to ascertain precisely what effect latitude itself to the exclusion of other causes may have upon the climate of a region.

The position of a country with reference to mountain chains or to large bodies of water has a profound effect on climate. Over any level plain, even in tropical regions, the temperature decreases in free air about 1° Fahrenheit for every 300 feet increase of elevation. Mountains thrust themselves up into this region of colder air and thus lower the temperature of their surroundings. Again, mountains have a strong influence on rainfall by facilitating the ascent of moist air currents flowing up their slopes, and so causing condensation and precipitation by dynamic cooling. On the other hand large masses of water have a conserving influence, lessening extremes of temperature, and their action is so powerful as to determine the difference between what is called continental and marine climates.

The valleys in a mountain region have greater extremes of temperature than the mountain tops, being usually warmer during the day and in summer, and colder at night and during winter, because the cold air flows down the slopes and accumulates in the depressions. The effect of the nature of the soil and soil covering is also important. The mean temperature of the soil is always higher than that of the air above it. There are great differences, however, in the amount of heat which different soils return to the air. In rocks the temperature is higher at all depths and at all times of the year than in the overlying air, consequently rocky soils give up more heat to the air than other kinds. In sandy land the upper layers only are warmer than air, while moist lands or bogs are colder because much of their heat is lost in causing evaporation. A covering of vegetation lowers the temperature of the soil, and changes in temperature over grass and forests are less than over bare soils. Incidentally forests conserve the rainfall, returning it slowly to the streams and diminishing the evil effects of drought.

The position of a place with reference to the prevailing path of storms determines the frequency of rainy days, the cloudiness, the winds, and all the variable phenomena called weather, which are non-periodic in occurrence.

THE PHYSIOGRAPHIC FEATURES OF PRINCE GEORGE'S COUNTY.

In order to correctly interpret the climate of Prince George's County it is essential to have some knowledge of its physiographic features, but as complete details will be found in other portions of this volume, it will only be necessary to give here a brief recapitulation of the main facts.

Geologists divide the region east of the Appalachian chain into two well-known physiographic provinces: the Piedmont Plateau, and Coastal Plain. In Maryland the Coastal Plain includes all that portion of the State lying east of a line extending from southwest to northeast through Washington, Baltimore, and Wilmington, Del., or about one-half the area of the State. The Coastal Plain is divided into two portions by Chesapeake Bay, the higher western division

being known as Southern Maryland. It includes St. Mary's, Calvert, Charles, and Anne Arundel counties, and all but the extreme western margin of Prince George's County.

The characteristics of the Coastal Plain, important from a climatic standpoint, are its low, level lands, composed mostly of unconsolidated sands and clays, and the deep indentation of the region by Chesapeake Bay, its rivers and tributaries. The elevation of the land is considerably higher in the western peninsula than in eastern Maryland, frequently exceeding 100 feet even along its eastern margin, and reaching 280 feet farther west near Washington.

Elevation does not, however, enter as an important climatic factor in determining the weather of the county and hence marked climatic differences are not to be expected. The causes that determine the prevailing weather in this area are to be found in general rather than local conditions and depend very largely upon the geographical position of the county with reference to the paths usually followed by the great storm areas as they move across the country. As these matters have been fully elaborated in Volume I of the Maryland State Weather Service further discussion in this connection will not be necessary.

Meteorological Data Available for Prince George's County.

The discussion of the climate of Prince George's County and the District of Columbia is greatly facilitated by the fact that there are such a large number of stations from which reports have been secured. Furthermore, these records, notably those from Washington, are especially valuable not only because they extend back over a longer period of time than the majority of available climatological records but also by reason of the fact that they were made by experts using the very best known instruments exposed in the most approved scientific manner.

Practically all the meteorological observations made at the following stations were made under the auspices of some organization or institution. It may be well to state briefly the more essential points in each system concerned as the instrumental equipment and hours of observation are uniform for each.

The observations made under the direction of the Surgeon-General's Office of the Army Medical Department are, as a rule, made at 7 a. m., 2 p. m. and 9 p. m., and include the reading of the barometer, the thermometer, hygrometer, raingage, force and direction of the wind and the state of the weather.

FIG. 2.—Map showing stations from which meteorological data are discussed.

The observations made under the direction of the Smithsonian Institution are also made at 7 a. m., 2 p. m. and 9 p. m., and include the same phenomena as the preceding observations except there are no readings of the barometer.

The U. S. Weather Bureau observations at the regular stations are made at 8 a. m. and 8 p. m., 75th meridian time, and include the readings of the barometer, thermometers (exposed, maximum and minimum), raingage, velocity and direction of the wind and the state of the weather. At voluntary, or coöperative stations, the Smithsonian system was continued until 1888 and then for a few years the observations were made at 8 a. m. and 8 p. m. Later the exposed thermometers were replaced by maximum and minimum thermometers which are read but once each day, usually late in the afternoon.

In the Maryland State Weather Service each station is equipped with a maximum and minimum thermometer and a raingage which are read once each day, the observer also noting direction of wind and state of weather.

In the tables which follow the monthly and the annual extremes are printed in heavy type instead of repeating them as a separate item. Letters appearing in the tables indicate the number of days missing from the original record for that month. Thus *a*, one day; *b*, two days, etc.

TABLE I.

METEOROLOGICAL STATIONS, PRINCE GEORGE'S COUNTY, MD.

Station.	Latitude. North.	Longitude. West.	Elevation. (Feet.)	Observers.
Bladensburg.....	38° 57′	76° 58′	105	Benj. O. Lowdnes.
Cheltenham.....	38° 44′	76° 51′	230	William F. Wallis. J. E. Burbank.
College Park. ...	38° 58′	76° 57′	170	Dr. C. M. Jones. Prof. H. J. Patterson
Fort Foote.....	38° 47′	77° 2′	150	Dr. Jno. W. Bayne. (U. S. Post Surgeon)
Fort Washington.	38° 42′	77° 2′	100	U. S. Post Surgeon.
Laurel	39° 6′	76° 52′	150	Dr. T. M. Baldwin.
Nottingham.....	38° 42′	76° 43′	25	Dr. Richard Brooke. A. P. Dalrymple.
Upper Marlboro..	38° 48′	76° 45′	112	J. Benson Perrie.
Washington, D. C.	38° 54′	77° 3′	112	U. S. Weather Bureau and others.

The foregoing table shows the stations from which meteorological data are included in the present discussion.

Temperature Conditions.

The average temperature conditions for Prince George's County are given in the following tables.

The average for the year is about 54 degrees and the range in the monthly mean temperatures is about 42 degrees. January, as a rule, is the coldest and July the warmest month of the year. The extreme maximum temperature (the highest ever recorded at any station in the county) as shown in the following tables is 105 degrees, recorded at College Park in July, 1898, and the extreme minimum temperature is 18 degrees, recorded at Laurel in February, 1899, indicating an extreme range for the county of 123 degrees.

It will be of interest to compare these temperatures with similar data for Garrett, the coldest county in Maryland:

County	Annual Mean	Warmest Month	Coldest Month
Garrett	47.0°	68.0° in July	24.0° in February.
Prince George's	54.5°	76.8° in July	33.3° in January.

Garrett County is much colder chiefly on account of its far greater elevation above sea level.

The average date of the last killing frost in the Spring is April 7 for Washington, April 16 for Cheltenham, and April 20 for Laurel. The latest date recorded for a killing frost is May 11, 1906. The average date of the earliest killing frost in the Fall is October 22 for Washington, October 21 for Cheltenham, and October 18 for Laurel. The earliest dates recorded for a killing frost are October 2 for Washington, October 9 for Cheltenham, and October 1 for Laurel.

Precipitation.

As Mr. Von Herrmann correctly points out, precipitation is an extremely variable element of climate, and very great differences may be found at stations not widely separated; no corrections can be

applied to short records of rainfall, the averages for the various stations in the county are given in the accompanying tables.

Prince George's County receives about 42 inches of rain per annum. While this amount is slightly less than that for most other counties farther north, it is not the lowest value in Maryland, which appears to obtain in Allegany County, where the annual rainfall is approximately 34 inches per annum. As in all other counties of Maryland the precipitation is quite uniformly distributed throughout the year.

The records at Washington covering 90 years show an annual rainfall of 43.5 inches. The greatest average occurs in July with 4.65 inches, or more than 10 per cent. of the annual total; and the least occurs in November with 2.71 inches, or about 6 per cent. of the annual amount.

One of the most significant things revealed by an inspection of the precipitation tables is the remarkably even distribution of the precipitation through the year. It is also interesting to note that during the entire period covered by these records—back to 1824—there is not a single month when no precipitation was recorded. On the average, precipitation to the amount of .01 of an inch or more occurs on 10 days out of each month. The fall is now and then excessive, but as a general thing it is moderate. There is probably no very material difference in the fall in the eastern as compared with the western portion of the county, but the records seem to indicate a slightly greater fall in the Patuxent valley than in that of the Potomac. Snow occurs every year, although in some years the amount is very small, amounting to between 15 and 20 inches.

Thunderstorms, not infrequently accompanied by hail, occur, especially during the summer months, being most frequent in May and August. The prevailing winds of winter are from the northwest and of summer from a southerly direction. The humidity of the air is not excessive, being probably less than 70 per cent. for the year. The percentage is highest, as a rule, in September and lowest in April and May. The percentage of sunshine and cloudiness during the year is about equal, the former possibly exceeding the latter by a small margin.

TABLE 11.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT BLADENSBURG.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
1855	35.5	27.2	40.2	55.5	63.6	70.3	75.8	73.4	67.8	54.1	45.4	35.1	53.6
1856	21.7	26.2	33.0	52.9	59.3	74.6	78.3	70.8	64.7	.....	43.4	29.3	.....
1857	20.4	41.2	37.9	44.4	61.7	71.7	75.5	72.6	67.2	56.8	43.5	34.1	52.3
1858	37.1	27.8	39.7	51.9	60.5	75.0	77.4	73.2	64.1	56.4	37.6	37.6	53.2
1859	34.6	36.6	46.6	50.8	63.4	69.9	74.1	72.9	65.6	50.5	47.0	33.7	53.8
1860	.....	.....	.....	51.1	.. ..	70.9	76.6	77.0	63.5	53.8	43.7	31.6	.....
1861	39.0	37.3	43.6	54.6	59.6	74.6	71.3	74.6	63.6	53.7	40.3	33.9	53.1
1862	33.0	33.0	38.5	48.4	60.8	67.2	75.4	. ....	..	67.5	.....	.....	..
1863	37.1	36.2	39.0	50.3	65.1	70.6	78.8	78.0	62.6	53.7	46.8	33.9	53.5
1864	33.8	37.3	39.9	51.6	67.1	71.3	75.5	79.6	65.4	54.0	44.0	37.7	54.9
1865	30.1	34.3	49.2	57.7	65.1	75.6	76.0	73.0	.....	.....	... ..	.....	.....
Mean	32.2	33.7	40.8	51.7	62.6	72.0	75.9	74.5	64.9	54 5	43.5	34.0	53.1

*The station at Bladensburg was among the first established by the Smithsonian Institution. It was opened in December, 1854, and continued in operation until August, 1865, giving a record of about 11 years. Mr. Benjamin O. Lowndes was the observer during the entire period.

TABLE III.

MONTHLY AND ANNUAL PRECIPITATION AT BLADENSBURG IN INCHES.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
1856	.....	.....	.. ...	.....	.....	5.24	2.29	6.48	2.41	1.69	1.96	2.25	.. ...
1857	.....	0.47	0.91	.....	5.11	5.18	3.92	6.90	1.42	2.43	.....	5.43	.....
1858	1.40	.....	.....	.....	5.66	1.17	4.12	1.17	2.54	1.79	4.26	.....	.....
1859	4.85	2.91	5.52	4.61	3.37	5.24	1.16	1.67	5.75	2.95	1.55	... ..	.....
1860	.....	.....	.....	2.88	5.73	3.27	2.69	3.65	3.26	3.55	3.05	2.56	.....
1861	.....	2.15	2.04	5.82	2.07	2.65	4.41	4.12	3.01	2.68	1.38	0.70	.....
1862	2.73	2.07	4.49	3.31	2.35	6.33	4.77	.....	.....	2.60	2.85	. ..	.....
1863	2.96	5.04	4.31	5.27	3.22	3.03	15.60	... ..	... ..	3.76	2.45	4.04	.....
1864	.....	.....	5.65	4.01	4.54	0.99	1.33	0.74	.....	1.42	3.58	.....	.....
1865	.....	1.32	4.08	1.90	2.97	1.92	2.68	0.98	.....	... ..	.....	.....	.....
Mean	2.98	2.32	3.86	3.97	3.89	3.50	4.30	3.21	3.06	2.54	2.64	3.00	39.27

TABLE IV.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT CHELTENHAM.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1901	... ..	.....	.....	.....	62.1	71.4	79.2	75.3	67.3	56.2b	40.5	33.0	.....
1902	31.2	29.0	46.8	53.0	63.5	69.7	75.5	71.0	65.5	56.8	61.0	33.4	53.9
1903	32.8	37.2	50.4	54.0	64.8	68.1	76.0	70.4	66.4	56.4	41.2	30.7	54.0
1904	26.7	27.1	41.3	49.8	64.4	70.1	74.1	72.3	67.4	53.5	42.1	30.6	51.6
1905	28.9	25.2	44.6	53.7	64.6	70.6	75.8	72.6	67.4	56.9	43.5	36.3	53.3
1906	39.4	33.3	37.0	54.9	63.4	72.4	74.4	76.2	71.6	55.6	45.7	35.6	55.0
1907	36.2	28.7	47.0	47.0	68.1	65.4	74.2	71.4	68.6	51.4	44.7	37.9a	52.5
1908	34.0	30.4	47.1	55.6	64.6	71.2	77.6a	72.2	66.6	58.6	46.2	37.4	55.1
1909	37.4	45.0a	42.6	55.0	64.6	73.3a	73.9	72.6	66.0	52.6	51.0	32.1	55.6
Average	33.3	32.0	44.6	52.9	63.3	70.2	75.6	72.7	67.4	55.3	45.1	34.1	53.9

*The station at Cheltenham was opened by the U. S. Weather Bureau in May, 1901, with Dr. W. G. Cady as the observer. He continued to serve until May, 1902, when the work was turned over to the Magnetic Observatory, U. S. C. and G. S., and so continued until July, 1905, when Mr. William F. Wallis became the observer. Mr. Wallis gave up the work at the end of June, 1906, and Mr. J. E. Burbank, the present observer, took it up. The station was supplied from the beginning with the standard Weather Bureau equipment.

TABLE V.

EXTREME TEMPERATURES AT CHELTENHAM.

Year.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1901.	Max..	.....	.....	.....	.....	84	97	100	90	93	85	72	66	100
	Min..	.....	.....	.....	.....	39	48	64	57	42	30	17	0	.....
1902.....	Max..	51	60	78	89	90	97	99	92	92	80	77	60	99
	Min..	6	—2	17	28	36	42	55	45	41	26	23	12	—2
1903.....	Max..	59	73	75	91	93	90	98	93	87	83	73	52	98
	Min..	10	3	21	25	36	46	47	51	39	32	15	7	3
1904.....	Max..	63	62	71	80	90	96	93	96	92	87	66	64	93
	Min..	0	—2	19	26	41	47	53	52	35	27	23	6	—2
1905.....	Max..	63	49	80	87	87	94	94	89	88	86	72	58	94
	Min..	—5	0	13	25	38	47	59	51	40	29	13	15	—5
1906.....	Max..	72	64	61	87	91	96	90	92	91	77	74	69	93
	Min..	9	6	14	25	29	54	53	62	50	29	26	10	6
1907.....	Max..	74	56	71	83	84	90	92	90	89	82	64	66	92
	Min..	9	0	20	22	36	45	52	54	38	29	23	16	0
1908.....	Max..	63	64	80	85	89	92	98	93	84	86	72	70	98
	Min..	10	4	23	28	38	49	56	49	40	34	22	12	4
1909.....	Max..	64	71	74	87	90	93	96	95	84	79	78	64	96
	Min..	10	76	21	22	34	49	49	51	38	26	24	6	6
Average No. days with Max. 90° or above		0	0	0.1	0.1	1	4	8	2	1	0	0	0	16.2
Average No. days with Min. 32° or below.....		25	23	14	5	0.3	0	0	0	0	3	14	24	105.3
Aver. daily range of temperature.		17.3	16.9	19.4	21.8	22.0	20.3	19.7	18.3	21.1	21.8	20.3	17.4	19.5

TABLE VI.

MONTHLY AND ANNUAL PRECIPITATION AT CHELTENHAM IN INCHES.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1901.....	.....	.....	.....	.....	2.50	3.32	5.59	5.22	2.83	1.08	2.63	6.38	.....
1902.....	4.49	4.92	2.98	2.80	2.06	5.05	5.06	0.97	4.85	7.03	3.28	5.19	48.68
1903	3.67	4.16	5.59	4.18	2.98	2.95	4.68	5.58	1.52	3.79	1.09	2.25	42.44
1904.....	2.32	2.01	3.63	2.70	2.56	4.58	4.31	1.34	4.21	2.20	1.50	4.09	35.45
1905	3.66	2.53	3.37	2.70	3.46	5.91	6.89	3.92	3.06	1.47	0.61	5.27	42.85
1906.....	2.93	2.70	4.83	2.86	2.92	8.81	5.87	7.40	1.25	6.11	2.27	2.73	50.62
1907.....	2.38	2.04	2.61	4.50	4.51	6.31	3.95	6.65	7.59	2.79	5.42	3.78	52.44
1908.....	3.77	4.08	2.24	1.53	3.13	2.14	6.07	10.61	3.95	3.00	0.98	3.60	45.10
1909.....	3.12	3.46	4.61	2.52	2.98	3.90	1.57	3.04	3.84	1.22	1.37	3.73	35.36
Mean.....	3.29	3.24	3.73	2.97	3.01	4.77	4.89	4.97	3.68	3.19	2.13	4.11	44.12

TABLE VII.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT COLLEGE PARK.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1889	39.3	32.3	45.4	54.2	63.6	70.1	74.3	70.6	66.2	50.7	45.6	44.9	54.8
1890	44.8	43.8	40.5	53.1	62.9	73.9	75.7	74.0	66.0	55.2	46.5	33.5	55.8
1891	36.3	41.4	39.3	55.4	61.1	75.0	70.4	72.0	65.1	55.2	42.2	42.7	54.3
1892	33.6	37.1	37.1	51.9	63.8	...	.....	73.5	63.2	52.0	41.4	31.7	.....
1893	22.9	34.2	39.9	53.7	60.0	69.2	77.0	73.0	63.6	53.6	42.2	37.8	52.3
1894	36.6	34.9	46.9	51.9	63.8	71.6	75.8	72.2	69.8	55.4	42.4	38.6	55.0
1895	29.4	24.9	41.4	51.7	60.6	72.6	71.1	76.2	72.4	52.4	48.5	40.6	53.5
1896	35.0	35.8	37.0	55.4	66.2	68.9	74.1	73.7	65.7	52.3	47.2	33.5	53.7
1897	27.5	34.2	44.0	52 5	60.1	.....	73.6	71.0	67.0	.....	.....	39.3	.....
1898	37.8	36.2	49.4	51.6	64.7	73.8	79.2	77.0	71.6	58.4	45.0	36.0	56.7
1899	.....	33.2	43.0	54.2	64.0	73.8	76.6	72.5	63.7	56.9	44.1	34.4	.....
1900	31.6	33.0	38.8	47.8	63.8	74.2	79.3	79.7	74.1	61.1	48.2	34.9	55.5
1901	32.4	28.0	44.2	49.9	60.8	69.3	79.0	74.4	64.4	53.8	38.3	31.6	52.2
1902	29.7	27.8	46.4	52.4	63.9	70.8	77.0	70.9	65.2	56.3	49.3	32.8	53.6
1903	31.6	35.2	48.6	52.1	62.1	66.0	74.6	71.6	66.2	56.6	42.8	30.0	53.1
1904	25.9	25.8	40.5	48.6	.....	70.1	74.4	73.3	67.7	54.6	43.1	29.2	.....
1905	28.9	25.4	45.6	55.3	63.8	69.8	76.6	74.0	67.2	57.2	43.0	36.4	53.6
1906	39.3	34.1	37.8	54.7	63.3	72.3	74.8	77.0	71.0	56.4	45.0	35.7	55.2
1907	35.8	28.1	47.8	48.2	58.8	64.8	74.0	71.4	68.4	49.6	42.8	38.4	52.3
1908	31.4	28.6	45.4	53.6	64.8	69.4*a*	76.4*b*	71.9	.....	55.8*c*	44.6*c*	36.2*a*	.....
1909	35.5	42.4*a*	41.6*b*	53.6	62.8	73.0*b*	73.6	72.2	.....	.....	49.8	31.2	.....
Average	33.1	33.2	42.9	52.5	62.7	70.7	75.4	73.4	67.3	54.9	44.6	35.7	54.2

*Observations were made at College Park from February, 1861, to February, 1862, also during the month of July, 1862, by Dr. C. M. Jones, of the Maryland Agricultural College, under the auspices of the Smithsonian Institution. For some reason the work was then discontinued until July, 1888, when it was again taken up under the direction of the United States Weather Bureau and the Maryland State Weather Service by Prof. Henry Jacob Patterson, also of the Maryland Agricultural College. The instruments in use belong to the State of Maryland. Draper's self-recording thermometer is also in use. The station is located in a gently undulating country.

TABLE VIII.

EXTREME TEMPERATURES AT COLLEGE PARK.

Year.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1889	Max.	66	53	67	78	96	90	96	94	89	86	74	72	96
	Min.	16	4	20	28	33	49	53	50	41	27	22	18	4
1890	Max.	80	74	77	82	86	96	102	97	91	78	74	59	102
	Min.	14	21	13	21	38	44	46	42	37	27	20	12	12
1891	Max.	58	72	60	84	89	94	86	94	92	86	68	65	94
	Min.	16	13	16	26	36	42	54	56	45	26	16	16	13
1892	Max.	62	59	64	79	86	92	100	95	88	83	69	64	100
	Min.	5	3	14	27	40	50	51	56	42	26	22	9	3
1893	Max.	50	63	64	80	87	96	98	98	86	84	66	64	98
	Min.	—16	9	17	30	37	50	52	50	32	24	18	16	—16
1894	Max.	57	59	82	82	86	99	100	96	96	84	70	56	100
	Min.	13	14	16	24	38	45	49	50	44	29	16	17	13
1895	Max.	49	63	72	85	94	100	99	98	101	77	78	69	101
	Min.	10	— 7	20	26	37	48	50	47	44	26	23	17	—7
1896	Max.	62	58	69	92	93	92	92	98	95	79	77	63	98
	Min.	8	7	10	24	36	45	51	44	34	26	21	7	7
1897	Max.	54	60	78	86	81	91	90	90	97	88	68	68	97
	Min.	—2	10	23	26	39	38	54	51	36	31	21	13	—2
1898	Max.	61	68	77	83	92	98	105	96	98	85	69	61	105
	Min.	16	11	25	24	35	48	48	54	41	27	28	4	4

TABLE VIII—*Continued.*

EXTREME TEMPERATURES AT COLLEGE PARK.

Year.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1899	Max..	57	59	71	84	92	98	96	96	87	79	70	64	98
	Min...	11	—4	22	27	39	51	56	52	36	28	20	—5	—5
1900	Max..	61	64	67	72	93	97	103	103	100	90	78	62	103
	Min...	6	4	6	27	37	52	50	55	39	29	23	9	4
1901	Max..	64	57	76	84	85	99	102	97	90	83	69	67	102
	Min...	6	7	6	31	36	47	61	55	37	25	14	2	2
1902	Max..	49	59	78	89	91	97	100	91	89	80	76	60	100
	Min ..	8	—3	18	27	35	43	54	45	38	26	23	7	—3
1903	Max..	56	72	71	88	91	92	96	94	90	82	78	51	96
	Min..	10	—2	21	25	31	43	49	50	32	28	12	6	—2
1904	Max..	61	62	72	81	90	98	95	96	95	90	68	60	98
	Min...	—9	—6	18	22	26	45	50	48	30	24	21	—9	—9
1905	Max..	68	51	82	87	90	94	101	100	89	90	77	59	101
	Min...	—13	—8	5	27	33	41	53	48	34	27	12	9	—13
1906	Max..	71	63	63	96	92	95	93	96	92	81	72	69	96
	Min..	6	6	11	21	27	48	54	61	45	23	20	12	6
1907	Max..	76	55	91	84	85	92	93	92	91	81	70	76	93
	Min...	5	—5	15	22	30	40	47	50	37	24	19	12	—5
1908	Max..	58	51	82	85	91	99	102	98	.....	89	69	67	102
	Min...	6	—8	18	22	34	41	47	45	.....	27	10	8	—8
1909	Max..	61	71	75	87	90	95	97	98	.....	.....	77	66	98
	Min...	8	12	20	19	31	44	42	46	.....	.....	23	5	5
Average No. days with Min. 32° or below..		25	23	16	6	0.5	0	0	0	0.2	5	15	24	114
Average No. days with Max. 90° or above.....		0	0	0.06	0.4	1.5	6	11	8	4	0.2	0	0	30

TABLE IX.

MONTHLY AND ANNUAL PRECIPITATION AT COLLEGE PARK IN INCHES.

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1889.....	3.68	2.36	4.47	9.20	8.47	6.80	8.73	1.78	3.58	4.60	5.85	0.26	59.78
1890.....	1.42	3.97	3.36	2.34	4.48	1.25	2.42	4.83	3.52	4.31	0.69	3.70	36.29
1891...	5.21	4.66	7.94	2.66	4.52	4.01	8.95	3.22	2.58	2.47	1.47	2.86	50.55
1892.....	4.94	2.56	5.25	4.17	4.47	4.24	4.31	0.46	3.82	0.46	3.06	2.75	40.49
1893.....	2.43	3.78	1.31	2.83	4.51	2.68	2 74	1.99	2.58	4.62	4.31	2.45	36.23
1894.....	2.06	3.86	1.27	3.16	3.90	1.81	2.86	2.56	1.65	3.41	1.60	3.86	33.00
1895.....	3.79	0.70	2.73	5.84	3.16	5.50	2.27	2.57	1.81	1.89	1.96	2.32	34.54
1896.....	1.81	5.51	4.61	1.29	2 54	2.00	3.23	1.91	4.15	0.98	0.44	2.50	30.27
1897...	1.97	6.11	2.91	3.35	7.45	3.49	5.29	3.02	1.78	4.00	3.98	3.30	46.65
1898.....	3.87	1.36	2.23	2.24	3.38	0.35	2.11	6 08	0.56	3.33	4.18	4.41	34.10
1899.....	3.57	8.00	5.90	1.71	4.22	2.50	5.90	5.51	5.45	1.35	2.95	1.62	48.68
1900.....	1.71	5.69	1.57	1.82	3.39	7.15	2.08	2.09	5.59	1.62	2.42	2.40	37.53
1901.....	1.75	0.90	3.53	6.40	4.17	6.72	5.74	4.93	3.69	1.47	2.78	6.70	48.78
1902.....	3.72	4.45	3.54	2.25	2 70	4.10	6.21	3.48	7.39	5.78	3.65	5.21	52.78
1903.....	3.75	4.34	5.54	4.37	3.10	5.27	6.55	3.51	0.61	4.04	.....	... ..	. .....
1904.....	...	.....	2.32	.....	1.79	6.28	4.07	3.02	....	2.27	.....	.....	.....
1905.....	2.81	.....	2.97	2.75	3.14	3.77	6.97	7.86	2.25	2.01	.....	2.74	.....
1906.....	3.21	2.11	4.35	3.44	1.73	7.56	6.81	9.34	0.50	4.04	1.55	3.38	48.02
1907.....	2.19	1.76	2.20	2.25	3.44	5.62	2.84	2.84	8.06	2.02	4.64	3.73	41.59
1908.....	2.88	5.08	2.94	1.96	4.27	1.41	... .	5.32	5.14	1.76	0.88	2.83	.....
1909.....	...	3.03	3.79	2.56	2.91	4.75	1.89	2.10	... ..	.....	0.78	2.90	.....
Average.....	2.99	3.70	3.55	3.33	3.89	4.16	4.60	3.73	3.41	2.79	2.62	3.16	39.96
Average number rainy (0.01 inch or more) days.	8	8	10	8	10	9	9	8	6	6	7	7	94
Maximum number rainy days.	13	12	13	13	17	14	15	16	11	12	14	12	120
Minimum number ralny days	3	2	5	3	4	4	4	2	1	2	2	2	66

TABLE X.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT FORT FOOTE.*

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1871.....	.....	.....	.....	.....	.....	.. ..	72.7	75.4	58.6	52.0	37.0	30.4	.....
1872.....	29.9	26.5	34.5	54.6	67 0	74.8	81 1	79.0	67.9	54.8	40.0	28.0	53.2
1873.....	29.4	32.8	39.3	52.3	62.3	73.5	77.9	73.9	66.5	53.3	39.3	38.6	53.3
1874.....	37.9	35.3	43.6	46.3	63.0	75.6	76.6	71.5	69.0	55.1	43 7	37.5	54.6
1875.....	27.8	28.9	39.6	48.9	63.5	73.4	77.1	71.8	65.0	54.9	41.6	36.0	52.4
1876.....	40 0	37.2	39.5	51.1	64.5	75.4	79.9	74.7	65.2	51.1	44.2	25.5	54.1
1877.....	29.0	38.0	40.8	52.9	51.4	74.0	78.0	75.9	66.9	58.4	45.9	41.8	55.3
1878.....	33.2	39.2	49.3	67.9	62.8	68.3	80.3	75.2	68.9	56.5	....	.....	.....
Mean.....	32.5	34.0	40.9	52.0	63.5	73.6	78.0	74.7	66.0	54.5	41.8	34.1	53.8

TABLE XI.

MONTHLY AND ANNUAL PRECIPITATION AT FORT FOOTE IN INCHES.

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1871.....	.....	.....	.....	.....	.....	.....	3.37	2.38	2.50	3.00	3.22	1.19	... .
1872.....	0.70	0.98	5.34	2.13	2.21	3.42	0.86	5.88	4.34	4.15	2.37	2.33	34.71
1873.....	3.31	4.36	0.87	2.33	4.34	1.86	4.93	8.37	1.63	3.52	2.40	0.76	38.68
1874.....	1.60	0.75	1.93	6.75	2.44	1.81	3.53	1.64	5.88	0.14	1.59	2.23	29.29
1875..	1.89	1.34	3.08	1.78	1.83	1.70	1.77	11.07	1.67	1.38	4.27	2.43	34.21
1876..	0.74	2.68	3.77	2.26	1.96	1.88	4.01	1.65	7.24	1.51	2.27	0.23	30.20
1877.....	1.64	1.12	2.30	3.27	1.64	4.65	2.95	2.81	6.08	6.68	4.99	1.52	38.55
1878.....	2.00	2.07	2.91	2.14	4.30	5.31	5.76	6.39	2.13	2.08	.....	.....	.....
Average ...	1.70	1.93	2.89	2.81	2.67	2.95	3.37	5.02	3.93	2.67	3.02	1.53	34.49

*The observations at Fort Foote were made by the post surgeon who, at the time, was Dr. John W. Bayne, and were taken in accordance with the rules governing the whole system of observation made under the direction of the Surgeon-General's Office of the Army Medical Department.

TABLE XII.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT FORT WASHINGTON.*

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1824	42.7	38.4	45.3	56.5	66.0	75.1	79.6	76.1	68.3	59.2	47.5	43.0	58.2
1825	37.4	40.5	50.1	58.9	66.9	78.2	81.5	78.7	69.8	63.6	47.3	39.1	59.3
1826	38.4	43.5	51.2	54.7	74.0	77.8	78.6	77.8	73.3	61.7	49.8	40.2	60.1
1827	31.2	46.1	51.4	62.7	66.2	74.4	80.0	77.0	69.6	60.2	46.8	41.3	58.9
1828	42.6	43.0	49.0	52.1	69.4	.....	.....	.....	.....	60.0	49.6	33.3	.....
1829	33.7	28.3	41.0	57.9	70.3	76.2	77.4	77.4	67.9	58.2	45.1	40.3	56.6
1830	35.2	36.0	49.4	60.7	69.4	77.3	83.6	79.1	70.8	62.1	53.8	38.4	59.7
1831	35.5	31.3	50.6	59.4	69.2	73.5	79.4	77.7	71.2	61.7	46.0	26.2	57.3
1832	35.5	38.6	46.9	56.7	67.1	76.5	81.1	77.3	69.9	59.1	50.9	39.9	58.3
1833	38.6	38.7	43.5	62.0	73.4	76.2	82.6	78.4	73.6	56.5	47.1	38.2	59.1
1834	31.3	45.6	44.4	55.8	64.9	79.2	83.0	79.8	71.4	56.5	43.2	37.9	57.8
1835	31.8	28.9	43.0	57.1	68.3	76.4	78 2	73.2	62.9	59.7	49.8	34.4	55.3
1851	.....	.....	.....	.....	66.0	72.2	78.5	74.6	68.1	58.0	43.1	31.2	.....
1852	29.3	37.1	45.3	50.1	67.3	73.2	78.6	72.4	67.4	60.6	43.8	42.1	55.6
1853	34.0	39.2	44.7	55.3	65.8	76.6	77.6	78.0	69.9	59.8	47.4	38.0	57.2
1868	.....	.....	.....	.....	64.1	73.5	81.1	76.5	69.1	56.2	47.5	33.0	.....
1869	40.6	40.5	42.6	54.1	61.0	72.3	76.6	75.8	68.4	51.2	40.4	37.8	55.1
1870	41.2	35.5	39.9	53.6	64.1	74.9	79.0	77.1	69.6	58.7	46.7	34.9	56.3
1871	.....	.....	50.5	60.2	65.5	75.3	75.8	78.8	65.1	59.7	44.6	32.6	.....
1872	31.9	33.6	35.9	55.7	67.6	75.2	80.6	79.3	.....	.....	.....	.....	.....
Mean	35.9	38.2	45.8	50.9	67.3	75.8	80.1	77.1	69.2	59.1	46.9	37.3	57.7

TABLE XIII.

MONTHLY AND ANNUAL PRECIPITATION AT FORT WASHINGTON IN INCHES.

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1851	.....	.....	.....	.....	3.77	1.42	4.92	3.51	2.27	1.95	3.66	1.78	.....
1852	1.54	3.23	2.88	7.05	2.29	3.51	2.89	11.54	1.75	2.20	6.96	4.64	50.42
1853	3.19	4.40	3.47	3.56	6.23	1.56	3.88	5.30	4.57	.....	.....	.....	.....
1868	.....	.....	.....	.....	6.65	3.67	6.73	5.70	6.43	1.44	3.00	3.16	.....
1869	4.55	.....	.....	2.86	4.06	2.31	1.48	0.50	1.25	7.10	2.31	4.68	.....
1870	3.26	2.58	3.34	2.90	3.93	4.89	2.46	2.09	1.64	.....	.....	.....	.....
1871	.....	.....	4.34	1.22	4.35	1.79	4.18	3.52	2.94	2.59	4.06	.....	.....
1872	0.72	1.30	3.34	2.21	1.18	2.10	1.16	4.01	.....	.....	.....	.....	.....
Average	2.65	2.88	3.57	3.30	4.06	3.28	3.46	4.52	2.98	3.06	3.99	3.56	41.31

*Fort Washington was one of the very first of the military posts to take up the meteorological work originated and carried on by the Surgeon-General's Office, but unfortunately there were two serious interruptions; one from 1835 to 1851, and again from 1853 to 1868. The work here as at many other Army Posts was discontinued upon the establishment of the United States Weather Bureau.

TABLE XIV.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT LAUREL.*

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annu'l
1895	.....	.....	.....	54.6	60.0	73.1	71 2	74.8	69.4	49.4	44.5	39.2	.....
1896	.....	.....	38.5	56.2	67.9	70.4	76.4	74.1	67.2	52.0	50.0	34.2	.....
1897	.....	36.2	44.4	51.3	61.3	67.9	75.4	72.9	67.0	58.2	45.0	35.9	.....
1898	35.8	33.2	46.9	50.0	63.2	72.0	78.1	77.8	74.4	59.8	45.7	36.8	56.1
1899	32.3	27.1	42.1	54.3	65.9	74.6	76.4	74.7	76.6	57.1	44.5	35.8	54.2
1900	33.4	33.2	36.6	52.8	63.4	71.6	77.3	79.1	73.6	61.0	47.6	34.8	55.4
1901	32.4	27.3	43.6	50.0	61.6	71.4	79.4	75.4	66.5	53.8	39.0	31.4	52.6
1902	29.4	27.6	44.2	52.7	63.2	70.2	76.2	71.8	65.6	56.4	49.8	32.3	53.3
1903	31.6	35.4	49.0	52.9	64.0	66.7	74.2	71.0	66.3	56.0	40.2	29.4	53.1
1904	27.4	29.5	41.2	48.4	65.7	72.1	75.5	73.6	68.2	53.6	43.6	29.8	52.4
1905	29.8	26.6	45.3	53.8	67.4	72.1	77.2	74.1	68.8	58.0	44.0	36.8	54.5
1906	40.4	35.4	38.1	55.5	62.0	72.0	75.8	76.3	71.5	56.1	47.0	37.4	55.6
1907	34.8	27.0	46.2	48.7	59.2	65.0	74.1	71.2	68.6	50.4	43.3	36.2	52.1
1908	33.0	29.8	45.8	54.5	64.3	71.5	78.4	72.5	65.8	57.8	43.8	34.7	54.3
1909	34.1	41.1	40.8	53.6	62.6	73.1	72.8	71.1	64.6	50.0	49.2	30.0	53.6
Mean	32.9	31.5	43.0	52.6	63.4	70.9	75.9	74.0	68.2	55.3	45.1	34.3	53.9

*The record at Laurel is an unusually valuable one in that it is entirely homogeneous, being the work of one observer throughout, made under identical conditions with standard instruments. The station was opened by the United States Weather Bureau in April, 1895, with Dr. T. M. Baldwin as the observer in charge and the Bureau has had the good fortune to retain his efficient services ever since.

TABLE XV.

EXTREME TEMPERATURES AT LAUREL.

Year.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1895	Max.	.....	.....	.....	86	93	.....	94	96	93	74	75	64	.....
	Min.	.....	.....	.....	34	36	.....	49	46	42	21	23	14	.....
1896	Max.	.....	.....	72	94	94	95	93	97	92	77	77	65	97
	Min.	.....	.....	7	26	38	49	55	49	37	26	24	6	.....
1897	Max.	64	58	80	87	82	90	92	91	95	90	67	62	95
	Min.	0	14	22	26	37	45	55	55	35	32	22	10	0
1898	Max.	60	61	72	80	92	99	101	98	100	85	67	67	104
	Min.	14	2	20	23	34	47	52	60	52	35	27	27	2
1899	Max.	56	60	74	88	94	101	97	98	95	79	70	67	101
	Min.	4	18	19	25	39	48	53	54	37	29	21	5	18
1900	Max.	65	70	68	83	95	93	103	102	100	90	80	64	103
	Min.	3	3	3	24	33	49	47	52	39	30	22	10	3
1901	Max.	64	55	77	88	89	99	103	92	91	84	72	66	103
	Min.	7	0	7	30	37	43	63	55	37	26	14	3	0
1902	Max.	50	57	77	91	93	98	101	92	92	82	78	58	101
	Min.	8	5	18	27	35	42	52	48	39	26	22	5	5
1903	Max.	57	71	73	91	95	87	96	97	90	85	75	49	97
	Min.	10	5	20	25	34	45	51	52	33	27	11	9	5
1904	Max.	62	62	72	83	94	97	95	95	95	89	67	58	97
	Min.	—7	7	16	21	38	50	56	50	35	28	20	- 2	7
1905	Max.	63	51	83	83	90	95	96	92	89	89	69	60	96
	Min.	4	1	18	28	45	49	60	50	38	32	16	15	1
1906	Max.	71	64	63	89	96	94	91	93	92	80	69	68	96
	Min.	8	9	15	27	27	54	56	60	49	25	20	12	8
1907	Max.	75	55	90	85	87	90	92	91	91	80	66	67	92
	Min.	5	0	15	22	32	42	50	52	39	25	21	12	0
1908	Max.	60	66	83	87	91	97	100	99	87	90	71	71	100
	Min.	5	8	19	24	30	46	58	50	39	30	9	9	8
1909	Max.	62	70	.....	88	93	95	97	97	86	80	78	65	97
	Min.	6	11	15	19	29	44	47	47	35	19	23	5	5

TABLE XVI.

MONTHLY AND ANNUAL PRECIPITATION AT LAUREL.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1895	.....	.....	.....	5.46	3.42	4.66	2.90	1.60	2.70	2.30	1.55	1.40	.....
1896	.....	.....	2.60	1.30	3.20	3.15	7.89	3.76	3.93	0.65	2.60	0.20	.....
1897	2.05	5.51	3.08	3.29	6.62	2.40	6.70	2.33	1.55	4.54	5.15	3.75	45.97
1898	3.30	0.92	2.64	2.07	4.70	0.65	1.72	7.20	0.78	3.65	2.97	4.14	34.84
1899	3.13	4.61	5.29	2.08	3.16	3.03	4.72	5.46	5.49	5.30	1.42	1.72	45.41
1900	1.67	6.12	3.51	2.01	2.67	8.28	3.90	0.85	5.23	2.73	2.75	2.51	42.23
1901	3.02	6.62	3.50	6.13	4.05	3.17	7.49	4.36	2.98	1.33	3.98	8.48	49.11
1902	3.15	6.41	3.71	3.11	1.38	4.11	2.89	3.70	11.42	6.83	3.70	5.59	56.50
1903	4.57	5.70	5.50	4.82	2.62	6.41	5.30	7.04	0.74	4.35	9.38	2.33	50.36
1904	2.20	.....	3.33	2.57	2.05	6.39	4.84	1.40	4.75	3.00	2.32	3.58	.....
1905	4.00	2.55	3.02	4.52	4.71	4.88	7.28	8.37	2.67	2.36	1.67	5.83	51.87
1906	3.59	2.23	5.50	3.35	2.72	5.59	5.78	11.20	0.88	5.22	1.98	3.68	51.59
1907	3.28	2.43	3.05	3.10	3.63	5.30	3.01	2.42	5.90	2.12	6.61	3.95	43.80
1908	3.85	2.38	2.82	1.20	3.88	1.20	.....	.....	.....	.....	.....	.....	.....
1909	3.50	3.82	6.73	2.38	5.07	5.41	1.69	1.21	3.35	1.15	0.98	4.47	38.66
Average	3.18	3.61	3.80	3.16	3.56	4.31	4.72	4.35	3.74	3.17	2.69	3.69	46.30
Average No. of days with .01 in. or more.	7	7	8	6	8	8	10	9	6	7	6	8	90
Max. No. of rainy days	14	11	13	9	12	14	13	18	13	12	10	12	1.22
Least No. of rainy days	3	1	6	3	5	3	6	4	1	2	3	1	70
Average Mo. Snowfall.	5.0	8.0	4.0	0.2	0	0	0	0	0	0	1.0	4.0	22.2

TABLE XVII.

TEMPERATURE AND PRECIPITATION AT UPPER MARLBORO.*

Year.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Mean Monthly and Ann'l Temperatures	1893.	.....	.....	.....	.....	61.8	73.0	77.4	73.9	65.5	56.0	42.0	37.4	.....
	1894.	37.8	33.1	48.2	52.7	66.2	73.1	.....	73.0	70.7	.....	43.7	35.4	.....
	1895.	30.6	24.5	41.3	52.8	62.1	74.0	72.0	76.0	71.0	50.8	45.9	37.2	53.2
	1896.	31.7	35.7	38.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Extreme Temperatures. 1893...	Max.	.....	.....	.....	.....	90	97	99	91	89	82	68	68	99
	Min.	.....	.....	.....	.....	38	52	55	53	39	26	17	7	.....
1894...	Max.	57	62	82	83	85	101	.....	93	98	.....	69	59	101
	Min.	14	13	16	28	40	45	.....	51	46	.....	17	6	6
1895...	Max.	62	65	73	88	96	100	96	97	96	75	78	67	100
	Min.	8	7	22	30	39	52	51	50	42	26	20	12	7
1896...	Max.	59	60	70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Min.	30	7	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total Monthly and Ann'l Precipitation	1893.	.....	.....	.....	.....	1.44	1.57	2.54	3.80	1.42	5.45	4.42	.....	.....
	1894.	.....	.....	.....	3.45	4.48	1.39	.....	2.17	1.16	.....	1.63	3.74	.....
	1895.	5.43	1.10	3.50	5.32	4.19	5.83	3.72	1.09	1.28	2.42	1.00	2.36	37.24
	1896.	1.80	6.8	5.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*This station was established under the auspices of the Maryland State Weather Service in May, 1893, and was discontinued in March, 1896. Mr. J. Benson Perrie was the observer. The record is both short and fragmentary—two very serious defects from a meteorological point of view.

TABLE XVIII.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT WASHINGTON.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1820	28.9	41.7	45.8	56.5	62.4	71.5	78.1	75.3	67.0	51.2	42.1	34.2	54.6
1821	25.6	38.9	40.0	49.2	63.5	73.5	71.9	77.7	70.1	55.2	41.7	33.7	53.4
1823	41.1	35.0	47.2	61.1	67.3	72.4	77.8	76.8	68.8	53.8	39.9	37.7	56.6
1824	39.5	35.0	42.8	54.3	64.0	72.8	77.3	74.6	67.6	56.1	43 1	39 7	55.6
1825	35.1	38.9	48.7	56.0	64.3	75.6	78.6	75.4	67.1	59.8	44.4	35.8	56.6
1826	35.4	41.1	48.8	53.0	72.7	75.7	76.8	75.8	71.9	58.3	45.6	36.0	57.6
1827	29.9	42.4	47.2	59.6	65.5	73.6	79.2	78.0	69.8	58.0	44.7	41.3	57.4
1828	39.1	45.2	48.0	49.6	63.1	77.8	76.8	77.7	67.9	54.2	48.3	39.9	57.3
1829	32.2	28.9	41.5	56.0	64.2	74.0	73.8	74.6	64.8	53 6	43.4	43.9	54.2
1830	38.5	38.5	46.2	55.9	64.5	72.7	80.4	77.6	68.9	58.3	52.3	37.0	56.7
1831	26.5	29.1	46.6	54.7	62.6	73.1	74.3	74.4	67.0	55.6	41.9	25.1	52.6
1832	31.7	36.9	44.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1833	35.3	36.4	41.4	57.8	69.3	70.5	76.9	74.1	68.5	53.5	43.1	37.2	55.3
1834	29.5	43.0	47.2	55.4	62.1	71.6	79.8	76.8	66.0	52.9	43.6	36.2	55.3
1835	29.8	28.8	41.2	53.0	64.8	74.3	77.3	75.6	62.0	59.4	49.1	33.3	53.2
1838	.....	.....	.....	.....	.....	.....	83.5	80.8	69.8	51.8	40.0	30.2	.....
1839	31.5	35.7	43.5	56.6	65.7	68.3	74.8	70.3	65 4	58.6	39.0	34.2	53.6
1840	23.9	39.6	45.3	56.4	63.8	70.9	75.3	75.5	62.9	56.0	43.2	30.3	53.6
1841	32.8	32.0	41.7	49.2	59.4	75.0	75.2	72.1	68.2	49.2	43.4	36.1	52.9
1842	36.7	39.3	50.6	56.3	61.6	71.6	.....	.....	.....	.....	.....	.....	.....
1846	37.3	33.2	46.7	57.6	67.4	71.3	75 9	76.5	71.2	55.0	50.0	39.2	56.8
1847	33.9	37.1	41.8	56.6	63.4	71.4	76.3	73.1	66.8	53.8	48.4	39.5	55.2
1848	36.6	36.3	40.0	57.2	67.4	74.4	74.9	73.5	64.5	55.6	40.0	44.1	55.4
1849	32.6	33.6	44.3	52.8	66.3	75.9	76.5	76.0	69.8	58.6	48.9	34.6	55.8
1854	34.1	37.0	46.4	50.9	68.1	74.1	80.5	73.6	67.4	57.5	45.1	32.4	55.6
1855	34.8	26.8	41.4	55.3	63.5	70.4	78.3	74.5	69.7	53.5	48.1	36.8	54.4
1856	21.3	26.8	35.2	54.3	61.3	73.6	78.4	72.2	67.0	54.4	43 8	31.5	51.7
1857	21.5	41.8	38.8	44.9	60.6	70.8	74.0	73.2	67.4	54.2	42.1	34.8	52.0
1858	39.8	30.8	41.7	53.0	60.2	75.6	77.6	74.3	66.1	58.0	41.3	39.6	54.8
1859	36.0	39.2	49.4	51.8	64.2	70.6	75.4	73.8	66.8	51.3	47.9	33.5	55.0
1862	35.0	35.8	41.2	50.4	63.9	67.8	73.0	74.4	68.3	58.6	44.4	36.3	54.1
1863	37.2	35.2	37.7	48.5	64.1	69.4	75.0	77.0	64.0	53.8	46.6	35.3	53.6
1864	33.4	35.9	39.6	50.2	66.4	70.9	77.2	77.4	65.2	53.9	44.7	35.1	54.2
1865	27.8	32.7	48.0	53.0	63.7	75.1	75.8	73.4	72.8	54.7	45.4	37.7	55.0
1866	31.3	35.0	42.4	56.4	61.0	73.8	78.0	70.2	68.7	57.3	47.1	33.3	54.4
1867	24.4	39.0	37.8	54.8	58.7	70.6	75.2	73.1	67.8	55.9	47.3	31.8	53.0
1868	29.3	27.2	42.9	48.5	60.8	71.0	79.6	74.7	66.7	52.4	44.2	31.0	52.4
1869	38.1	38.4	39.9	52.5	59.7	71.2	75.1	75.3	67.2	49.6	38.9	37.1	53.6
1870	39.3	34.6	38.9	52.6	63.2	73.7	78.1	75.9	68.5	57.7	44.8	34.0	55.1
1871	32.6	35.9	48.0	58.2	63.9	73.2	74.0	76.8	62.3	58.1	42.3	32.1	54.8
1872	31.7	33.7	35.4	56.0	67.4	75.4	81.1	79.0	69.0	55.5	42.5	30.3	54.8
1873	30.9	34.8	41.8	53.1	63.6	75.1	79.8	74.8	68.0	54.9	40 8	40.5	54.8
1874	40.3	37.2	44.5	47.6	63.8	77.5	78.9	71.6	70.1	55.9	44.6	39.2	55.9
1875	29.5	28.8	39.1	48.0	63.6	72.9	77.0	71.9	64.6	53.6	41.0	36.8	52.2
1876	40.8	36.7	39.4	51.4	64.5	75.8	81.4	75.5	65.2	50.7	45.2	26.5	54.4
1877	29.4	39.4	41.0	52.9	61.9	73.9	77.8	76.3	66.9	58.6	46.2	41.8	55.5
1878	33.5	39.8	49.4	58.3	62.5	69.1	80.2	75.0	68.9	57.0	45.4	33.3	56.0
1879	30.8	31.6	43.5	51.8	65.3	72.9	78.6	73.9	64.4	62.0	45.6	41.1	55.1
1880	41.9	40.8	41.8	55.5	70.5	73.5	76.7	74.9	67.9	54.9	40.2	29.0	55.6
1881	27.6	32.8	40.1	50.3	67.0	70.7	77.4	76.5	77.0	62.9	47.5	41.7	56.0
1882	33.2	40.4	44.1	50.8	59.2	73.8	76.0	73.9	69.1	60.9	42.9	34.1	54.9
1883	29.6	37.5	37.6	50.9	63.6	74.4	76.8	72.1	65.1	56.9	47 2	36.9	54.1
1884	29.4	40.9	42.2	50.9	64.4	72.5	74.2	74.2	71.7	59.6	44.7	36.0	55.1
1885	32.9	26.9	34.5	53.1	62.3	71.1	77.8	73.4	66.1	54.7	45.3	37.5	53.0
1886	28.9	32.1	42.0	55.5	62.1	69.9	73.9	73.1	69.3	57.6	46.1	30.7	53.4
1887	32.9	38.9	38.5	51.6	67.9	72.1	80.5	73.2	65.0	55.4	44.9	37.2	54.8
1888	29.2	35.7	37.4	52.9	62.7	73.0	73.6	75.8	64.8	52.8	47.4	37.5	53 6

*The data in the above table were furnished by the Central Office of the United States Weather Bureau. The observations were made under the auspices of several institutions. Prior to the establishment of the Weather Bureau in 1870, records were kept by the Smithsonian Institution, the United States Naval Observatory, the Surgeon-General's Office, U. S. A., and by various private parties. As it is neither practicable nor desirable to publish all these records in this report, only the data compiled by the Central Office will be used, as these are no doubt as reliable and homogeneous as it is possible to secure. The mean temperatures and the average precipitation given above are those for the United States Weather Bureau record only, and not for the entire series.

TABLE XVIII—*Continued.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1889	39.2	31.1	43.4	54.4	64.6	70.8	75.8	72.4	65.6	52.5	46.2	45.6	55.1
1890	43 8	43.4	41.4	53.6	63.8	74.8	75.0	73.6	67.8	56.4	48.0	34.2	56.3
1891	37.4	41.4	38.6	55.4	61.4	71.6	72.0	74.5	70.3	54.4	44.0	43.2	55.4
1892	31.6	37.0	37.7	51.4	63.8	76.6	75.8	76.2	66.1	55.4	43.7	33.2	54.0
1893	24.6	35.1	41.1	53.8	61.6	72.5	77.0	74.6	66.0	56.5	43.6	38.3	53.7
1894	37.8	35 2	48.5	53.2	65.9	73.6	77.9	74.0	71.4	57.9	44.0	37.4	56.4
1895	31.6	26.2	41.8	53.8	62.6	74.6	72.8	77.2	72.4	52.1	46.4	38.8	54.2
1896	33.3	36.7	38.5	56 6	68.8	71.3	76.7	75.8	67.8	54.0	50.6	35.6	55.5
1897	31.0	36.6	46.0	57.9	62.4	69.6	76.9	73.4	68.2	58.0	46.0	38.1	54.9
1898	36.6	35 0	48.8	50.9	64.4	73.4	78.8	76.9	71.0	57.8	44.0	35.6	56.1
1899	33.4	27.4	42.2	54 0	64.4	74.3	76.6	74.8	65.8	58.5	45.3	36.2	54.4
1900	35.2	33.7	38.8	54.2	64.4	72.2	78.7	79.6	73.6	61.6	49.2	36.5	56.5
1901	34.4	29.8	45.0	50.6	62.5	72.4	79.8	76.0	67.4	55.6	40.6	34.8	54.1
1902	31.8	29.8	46 7	52.9	65.4	71.8	77.0	72.6	66.8	57.6	51.3	34.4	54.8
1903	33.4	37.4	50.0	54.0	64.4	67.0	76.0	71.8	67.2	56.8	41.6	32.2	54.3
1904	27.5	28.4	42.2	49.7	65.0	71.0	74.4	72.3	67.4	54 1	43.1	30.9	52.2
1905	29.8	26.4	45.0	54.0	65.2	71.8	76.4	73.6	68.2	56.9	44.4	37.5	54.1
1906	40.0	34.0	37.6	55.5	64.4	72.8	75.2	76.4	72.9	56.9	47.8	37.0	55.9
1907	37.2	30.2	48 8	48.4	59.2	65.9	75.8	72.4	69.4	52.0	44.5	38.1	53.5
1908	34.2	30.8	47.4	56.4	65.3	71.8	78.0	73.2	66.6	58.2	46.0	37.0	55.4
1909	36.0	43.0	42.1	54.4	64.4	73.4	74.7	73.0	66.3	53.1	50.8	31.8	55.2
Mean	33.5	34.7	42.4	52.8	64.0	72.5	76.8	74.3	68.2	56.3	45.3	36.4	54.8
Extreme Maximum Temperature	76	78	93	93	96	102	103	101	104	92	80	73	104
Extreme Minimum Temperature	—14	—15	4	22	33	43	52	49	36	26	12	—13	- 15

TABLE XIX.

MONTHLY AND ANNUAL PRECIPITATION AT WASHINGTON IN INCHES.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1824	1.50	2.65	1.98	4.30	1.58	4.26	2.45	2.43	2.62	1.23	1.24	2.76	29.00
1825	1.62	2.27	3.83	3.35	2.37	2.66	1.87	1.35	0.45	1.68	0.24	2.76	24.45
1826	0.60	2.01	1.68	0.45	0.80	1.87	2.66	2.37	1.60	1.08	2.05	1.62	18.79
1827	0.48	2.85	1.18	1.97	2.25	1.37	.....	.....	.....	1.02	2.57	2.21	.....
1828	1.88	3.24	3.33	4.06	3.24	1.59	1.91	1.39	1.37	1.04	0.05	0.45	23.55
1829	6.20	2.00	2.74	3.12	2.49	1.79	7.84	5.23	3.12	1.78	3.81	2.97	43.09
1836	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47.27
1837	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31.80
1838	.....	.....	.....	.....	.....	.....	3.08	0.92	8.29	3.96	3.41	1.70	35.10
1839	4.74	2.68	0 94	2.66	3.67	3.96	3.95	6.03	1.86	1.58	4.98	1.27	38.33
1840	[3.05]	2.60	1.90	3.92	2.06	2.66	5.16	3.10	2.13	4.70	1.70	3.50	[36.47]
1841	6.90	1.79	5.66	4.72	2.73	2.09	3.50	4.70	1.81	3.98	2.24	4.99	45.11
1842	1.73	3.89	1.75	4.84	6.96	3.00	.....	.....	.....	.....	.....	.....	.....
1846	2.21	1.66	3.15	3.22	5.68	5.02	3.47	5.44	0.26	3.36	6.57	1.57	41.61
1847	2.01	5.22	2.18	0.31	1.31	2.62	3.03	2.79	4.79	6.84	2.25	2.47	35.82
1848	1.87	1.04	1.64	0.89	2.64	2.53	5.26	1.44	1.20	2.32	1.27	1.14	23.24
1852	2.45	2.87	2.53	3.90	1.13	3.76	4.13	8.77	0.85	1.49	5.03	3.59	41.50
1853	1.19	2.48	2.48	3.90	3.99	1.84	3.37	3.69	3.76	3.86	1.64	1.23	33.43
1854	3.75	4.95	1.69	5.23	2.55	1.57	1.68	0.63	3.20	1.91	3.59	0.82	31.57
1855	1.69	1.53	1.51	1.04	1.34	5.51	4.15	2.42	3.13	3.38	1.06	2.98	29.74
1856	3.79	0.60	1.63	2.54	3.94	5.94	3.58	3.71	1.85	1.80	2.01	2.25	33.64
1857	1.34	0.52	1.39	2.33	5.60	5.98	4.31	9.13	1.80	2.04	1.35	5.64	41.43
1858	1.89	1.31	0.95	3.77	6.90	1.58	4.54	4.03	2.74	2.52	3.83	5.52	39.58

TABLE XIX—*Continued.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1859	4.20	3.08	3.50	4.50	3.35	4.73	1.52	2.91	5.90	2.35	1.70	4.58	42.32
1860	2.52	2.12	9.94	3.35	5.78	2.29	2.53	4.73	4.31	3.72	3.10	2.24	37.63
1861	3.93	1.84	2.36	4.73	3.03	3.82	5.34	7.20	2.37	3.72	4.30	1.00	43.64
1862	3.00	2.94	4.98	5.18	2.50	4.41	5.48	2.30	1.70	3.02	2.57	0.98	39.06
1863	4.40	3.47	5.33	5.02	3.15	1.84	7.88	1.06	2.84	4.51	1.96	3.67	45.13
1864	2.42	0.33	5.38	6.93	4.57	0.80	1.36	4.16	2.51	1.30	3.36	3.16	36.28
1865	4.23	2.35	5.60	3.93	6.13	5.10	7.52	1.46	3.11	2.08	2.24	5.01	48.76
1866	3.35	4.95	0.95	3.36	2.52	3.33	7.85	1.98	5.80	10.61	1.71	2.97	49.38
1867	1.38	5.83	9.17	2.21	5.51	6.31	2.60	11.22	2.20	6.74	1.27	3.38	57.82
1868	4.10	1.96	2.18	3.03	5.16	5.31	5.27	5.04	5.70	1.97	4.20	3.07	46.99
1869	4.53	4.36	3.81	2.20	4.77	3.56	2.94	0.79	2.36	7.21	1.96	5.42	43.91
1870	2.66	2.68	3.98	3.70	4.63	4.34	4.11	2.05	2.00	4.27	1.57	0.46	36.45
1871	2.20	1.99	5.92	1.54	3.45	4.78	6.10	1.59	2.70	1.50	4.85	1.36	37.98
1872	0 23	0.93	3.22	1.74	1.43	2.78	0.82	5.72	3.92	4.83	2.75	2.49	30.86
1873	3.73	4.69	3.03	3.19	5.21	1.63	4.30	6.83	3.48	5.62	3.02	0.97	45.70
1874	1.89	1.84	2.06	5.65	2.82	3.47	2.34	1.71	7.84	0.29	2.08	2.59	34.58
1875	1.86	2.65	3.96	2.29	1.01	2.06	3.05	12.93	1.98	1.86	3.95	3.51	41.11
1876	1.68	3.50	5.52	2.43	3.02	4.59	5.12	4.17	10.81	2.99	2.83	1.30	47.96
1877	3.73	1.16	3.58	4.87	2.26	5.92	6.50	2.74	4.93	6.50	7.18	3.22	52.59
1878	4.77	2.54	4.31	3.32	5.27	6.33	8.37	8.89	2.46	5.86	3.03	4.94	60.09
1879	3.13	1.87	1.74	2.39	1.58	3.29	3.36	7.36	1.56	0.79	1.10	4.66	32.83
1880	2.51	1.71	5.60	3.81	3.37	3.52	2.25	3.83	3.42	2.31	2.48	4.02	38.83
1881	5.14	4.01	6.61	2.08	1.86	5.71	1.67	1.07	2.19	3.29	2.45	6.12	42.20
1882	7.09	5.09	3.75	2.55	5.00	2.33	4.46	4.44	7.84	0.53	1.33	2.38	46.79
1883	3.15	5.08	3.27	4.09	2.50	8.55	4.73	3.30	4.33	2.63	1.19	2.89	45.71
1884	5.59	6.84	7.24	1.86	30.9	6.95	7.39	1.01	0.14	1.73	3.42	4.70	49.96
1885	4.46	4.63	1.53	1.71	2.85	3.30	3.03	6.49	2.15	8.69	3.33	2.67	44.84
1886	5.01	4.32	6.41	2.71	10.60	6.75	10.68	2.43	1.79	1.20	2.88	3.44	58.17
1887	2.39	3.42	3.83	3.24	2.50	2.99	3.29	2.34	3.12	1.82	1.83	4.31	35.18
1888	2.99	3.19	4.53	1.89	4.77	3.53	4.47	3.35	6.82	3.27	2.97	3.27	45.05
1889	4.05	2.47	4.20	9.13	10.69	5.01	8.13	3.07	3.88	4.48	6.03	0.19	61.83
1890	1.54	4.20	3.65	2.81	4.73	2.02	3.24	5.50	4.22	5.15	0.79	3.74	41.51
1891	6.14	4.49	8.84	2.94	3.72	4.61	8.40	4.18	3.12	2.24	1.47	2.80	52.95
1892	5.84	3.64	5.70	4.52	4.07	2.59	5.04	0.85	3.55	0.34	3.38	2.82	42.34
1893	1.85	4.25	1.83	3.21	5.41	1.81	1.44	2.32	3.91	4.11	4.30	2.27	36.71
1894	2.14	4.64	0.98	3.34	4.03	1.24	2.14	2.00	1.53	3.14	1.52	4.15	30.85
1895	4.42	1.10	2.59	6.26	3.09	4.34	4.50	1.26	1.11	1.94	1.26	2.38	34.25
1896	2.27	5.31	5.16	1.07	2.26	2.39	3.69	2.65	3.18	0.34	2.54	0.30	31.16
1897	1.98	6.47	2.66	3.02	6.97	2.60	5.78	3.35	1.54	3.55	3.31	3.35	44.58
1898	3.54	1.64	2.52	2.36	3.60	1.33	2.86	8.76	0.89	3.54	3.12	3.56	37.72
1899	4.12	6.17	4.94	1.54	2.53	2.46	6.06	3.77	6.14	2.80	1.81	1.68	44.02
1900	1.92	5.26	3.07	1.74	4.02	10.94	1.25	2.28	4.61	1.44	2.15	2.52	41.20
1901	2.92	0.62	2.64	6.34	2.81	4.66	5.17	4.12	1.61	0.97	2.33	7.56	41.75
1902	3.61	4.72	3.78	2.22	3.35	3.70	2.54	1.85	5.30	6.76	3.46	5.29	46.58
1903	4.26	5.32	5.73	4.29	2.75	3.60	5.17	4.52	0.74	4.48	0.80	1.89	43.55
1904	2.62	1.65	3.02	2.98	2.64	5.49	6.25	2.97	5.34	2.35	2.20	3.33	40.84
1905	3.59	2.55	3.31	2.69	3.22	4.52	9.95	9.75	2.34	2.30	1.03	5.39	50.64
1906	3.11	2.14	4.62	3.03	1.80	5.89	6.80	14.36	0.60	5.71	1.63	3.23	52.92
1907	2.54	2.31	2.79	3.61	5.03	4.86	1.55	4.34	7.15	2.12	4.16	4.20	44.66
1908	3.45	3.98	2.45	1.60	6.10	1.73	3.29	5.14	4.64	1.71	0.60	3.63	38.33
1909	2.84	3.11	4.76	2.69	3.77	3.82	1.80	2.27	3.42	0.79	0.89	3.39	33.55
Mean	3.37	3.42	3.85	3.25	3.83	4.18	4.65	4.40	3.59	3.09	2.71	3.16	43.50
Greatest monthly precipitation	7.09	6.84	8.84	9.13	10.69	10.94	10.63	14.36	10.81	8.69	7.18	7.56	.....
Year	1882	1884	1891	1889	1889	1900	1886	1906	1876	1885	1887	1901	.....
Least monthly precipitation	0.23	0.62	0.98	0.91	1.01	1.24	0.82	0.85	0.14	0.29	0.79	0.19	.....
Year	1872	1901	1894	1871	1875	1894	1872	1892	1884	1874	1890	1889	.....
Average number of rainy days	12	11	12	11	12	11	12	11	8	9	10	10	1 29
Average relative humidity	73	70	66	63	71	73	74	75	78	76	74	72	72
Prevailing wind	N.W.	N.W.	N.W.	N.W.	S.	S.	S.	S.	S.	N.W.	N.W.	N.W.	N.W.

The Weather at Nottingham.

The following records are credited to Nottingham, although there is nothing in the published record to show just where it was made, except that it was made "in Maryland." The observer, Dr. Richard Brooke, was born near Nottingham, Prince George's County, on the old family estate known as "Brookfield," where he lived and died and where it is very probable these records were made. Dr. Brooke seems to have been a prominent, active man in his day, being a practicing physician and taking an active part in political matters. The record was published in the Philosophical Transactions of London for 1759, that of the first year (September 1, 1753, to August 31, 1754) being published in full and that for subsequent years only the highest and lowest temperatures in each month together with the general character of the weather of the month, and occasional remarks about unusual weather conditions or prevalent diseases. We have omitted all notes relative to epidemics, diseases, etc., and have given *verbatim et literatim* those relative to the weather. It is unfortunate that nothing is known as to the character of the instruments used, the manner of exposing same or the hours at which the readings were made, but as this is probably the first record of instrumental observations of the air temperature in Maryland, its historical if not its scientific value would seem to justify its publication in the climatology of the county. The temperature readings are no doubt observed readings and were probably made about 7 a. m and 2 p. m. daily, these being the hours, approximately, of the lowest and highest temperature during the day.

TABLE XX.

Extreme Temperatures at Nottingham.

Year.		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1753	Max	....	.....	....	.....	.....	.....	.....	.....	87	74	63	69
	Min	.....	.....	.. .	.....	.....	.....	.....	.....	58	36	36	11
1754	Max	64	61	71	73	85	87	87	88	80	80	67	60
	Min	15	10	27	42	45	56	61	62	73	34	23	23
1755	Max	69	64	79	83	87	90	93	90	93	75	65	71
	Min	23	14	24	40	47	70	60	61	45	36	29	15
1756	Max	73	70	.....	83	81	86	93	93	92	90	73	63
	Min	15	27	.....	29	48	44	69	68	60	29	27	13
1757	Max	65	67	65	67	88	90	90	90	88	67	65	68
	Min	10	8	30	35	48	72	64	67	47	43	33	28

NOTES ON THE WEATHER.

1753—	October:	Frost on 29th. Snow on 30th. Thunderstorm on 4th.
	November:	Snow on 14th and 23d.
	December:	Snow on 17th, 22d and 28th.
1754—	January:	Snow on 2d, 6th and 24th.
	March:	Thunderstorm on 5th, 21st, 22d, 24th and 28th.
	April:	Frost on 11th, 12th, 13th and 28th. Snow on 20th. Thunderstorm on 26th.
	May:	Thunderstorms on 12th, 13th, 14th, 15th, 16th, 21st, 24th, 25th, 26th, 27th and 28th.
	June:	Thunderstorms on 2d, 3d, 4th, 6th, 19th, 23d, 27th, 30th.
	July:	Thunderstorms on 10th, 12th, 15th, 16th, 17th, 18th, 19th, 20th, 22d, 23d and 30th.
	August:	Thunderstorms on 13th, 14th, 15th, 17th, 18th and 20th.
	September:	Winds for the most part easterly, and very rainy.
	October:	Winds easterly, and much rain in the beginning; latter end fair.
	November:	Winds variable. Snow and rain.
	December:	Much rain.
1755—	January:	Much rain. Snow on first day.
	February:	Much snow.
	March:	Much rain.
	April:	On the 16th it snowed as hard as ever I knew. Cleared up at 2 P. M. All dissolved before night. Not one shower of rain this month. Wind easterly till the 14th, afterwards mostly westward.
	May:	Extremely dry; seldom any clouds; no rain. Every vegetable almost burnt up; strawberry leaves, green plantain and others so crisp as to crumble. In this month many cattle died for want of food.
	June:	Seasonable weather.
	July:	Very dry.
	August:	Very dry.
	September:	Very dry.
	October:	Seasonable weather toward the end of the month. This was the driest summer and autumn ever remembered. Many springs dried up that ran brisk before. My spring, a remarkably good one, ran very low and the water was unpleasant.
	November:	On the 18th I felt three shocks of an earthquake about eight minutes before 4 o'clock in the morning. The first was severest. It shook the house very much and waked me. The second was less, and the third least of all. They succeeded each other at about the one minute distance, and were felt all over the continent
	December:	On the 16th there was a brisk southerly wind. The mercury about noon at 71°, at 4 P. M., at 69°. At 5 P. M. o'clock the wind came from the northwest, blew excessively hard, and did great damage in the country. A prodigious quantity of rain fell. It cleared up at 6 o'clock, but the wind continued blowing hard all night. At 8 o'clock the mercury was at 43°, at 7 o'clock next morning at 26°, at 9 o'clock at 24.5°, and following morning, *viz.*, the 18th, the mercury was at 15°.
1756—	March:	No record, being hindered by business.
	April:	Seasonable weather.
	May:	Seasonable weather.
	June:	Plenty of rain. The season much colder than usual. Mercury standing frequently between 60° and 70°. On the 22d, in the morning, a black cloud came from the northward, soon overspread the hemisphere and threatened much wind and rain, but soon blew over without much wind or rain. The sun shone clear, and the weather calm, till toward noon, when clouds collected toward the north and northwest. About 3 P. M. there was the most threatening appearance I ever beheld, the clouds in some places of a deep green, in others of a sooty black. At 45 minutes past 3 it began to rain and blow, attended with remarkably severe thunder, but as the thunder stopped the clock I cannot say how long it lasted, but suppose near half an hour, in which time the most rain fell I ever saw. The wind did incredible damage in several parts of the country. In St. Mary's county, it is said, 200 houses were blown down and many people killed. In every county in Maryland much damage was done by this gust, which was the most general ever remembered. It was all over New York, the Jerseys, Pennsylvania, Maryland and Virginia, and did much damage everywhere. How much further it extended, either northward or southward, I have not heard.

	Juiy:	Seasonabie weather, and the most plentifui appearance of corn and tobaeco I ever saw. The wheat was got in iast month. It is supposed there wiii be the most of any year since the settiement of the country.
	August:	Very dry.
	September:	This is the hottest and driest summer ever known in Maryland. There are great crops of eorn and tobacco made, but, through the extreme dryness of the weather, the iatter erops of neither wiii eome to perfection. Many springs are dried up that were ever current before.
	Oetober:	Tbe weather seasonabie.
1757—	January:	Many sudden aiterations as to heat and cold have been in this month, but the most remarkabie I have ever observed was the iast day of this month, when the mercury was up to 65°, and the next day, February 1, when it was down to 28°, about the same hour in the day.
	February:	It rained almost every day this month.
	Mareh:	A vast deai of rain feii this month.
	Aprii:	The wettest and coldest Aprii within man's memory.
	May:	Seasonabie and healthy.
	June:	An uncommon wet month. The hard rains beat off the flour, or *farina fecundans*, of the wheat, so that very iittie of that grain was made this year.
	Juiy:	Much rain.
	August:	Mueh rain and thick foggy weather.
	September:	Very wet.
	Oetober:	Very wet.
	November:	On the 10th of this month there was as severe a gust of thunder and iightning as is common in Juiy or August. Severai horses, eattie, etc., were kiiied in different parts. There were the most iuminous coruscations I ever saw, the whoie hemisphere, as it were, in a biaze.
	December:	Very variabie weather. Many high winds and much rain.

THE HYDROGRAPHY OF PRINCE GEORGE'S COUNTY

By

F. H. NEWELL

Introductory.

Prince George's County, situated between two tidal rivers, Patuxent on the east and Potomac on the west, is drained by small tributaries of these two rivers. With the exception of the important power development on Patuxent River at Laurel on the northeast boundary of the county, there is no water power of any considerable value in the county, although several small powers on the tributaries are used at grist mills. The tide in Patuxent River, which has a mean range of 1.5 feet at Nottingham in the southern part of the county, flows to the "Fall-line" at Laurel. On Potomac River along the west boundary of the county the mean range of tide is about 3 feet. The soil is generally sandy. The surface is rolling and hilly and is in farm lands with small forest areas. There is no irrigation.

The Patuxent River Drainage Basin.

This river has its headwaters in Howard and Montgomery counties, and pursues a southeasterly and then a southerly course, forming the boundary line between the counties of Howard, Anne Arundel and Calvert on its left, and Montgomery, Prince George's, Charles and St. Mary's on its right, and empties into Chesapeake Bay 18 or 20 miles above the mouth of the Potomac. Its length, measured on a straight line, is 80 miles and its drainage area is about 960 square miles. It is navigable 40 or 50 miles from its mouth and crosses the "Fall-line" near Laurel. Its basin includes a hilly and rolling country with no lakes, and soil of sand and clay with some limestone in parts. The flow of the stream is very variable; the bed

is often rock, sometimes overlaid with a thin layer of gravel, and the fall is quite rapid. There are several important power developments, notably at Laurel and Guilford. At Laurel a total of about 260 horse-power is used, which can generally be obtained during only 9 months, or less, of the year. Of these, 60 horse-power are used in the Avondale Flour Mill and the remainder in the Laurel Cotton Factory.

THE PATUXENT RIVER AT LAUREL.

This station, which was established August 3, 1896, on the bridge on the main cross street of the town of Laurel, Md., was discontinued August 10, 1898. The initial point for soundings was the end of iron truss on the upstream side of the bridge. A wire gage with metal weight was attached to the lower side of the bridge, the scale being a 14-foot board spaced to tenths of a foot with small nails, and fastened to the floor timber of the bridge. The bench mark is a copper bolt set in a large capstone of the retaining wall on the lower side of the bridge abutment on the left bank of the stream. It is 21.22 feet above zero of gage height. The drainage area is 137 square miles. The flow of water past this station at low stages of the river is confined to certain hours of the day, on account of the influence of the dam at the large cotton mill situated about 1 mile up the stream from the station.

In the following table are the results of the several current meter measurements of the quantity of water flowing past this station in cubic feet per second at various stages of the river. Each of these measurements has been plotted as a point on cross-section paper, using gage height and discharge as coordinates and a smooth curve, called the rating curve, has been drawn in such a position as to average in a general way the inconsistencies and inaccuracies of these points. The rating curve shows the probable discharge of the river at any gage height, and from it has been made the rating table which follows the table of discharge measurements. The record of daily gage height shows the fluctuations of the river from day to day, and when applied to the rating table enables one to estimate the daily discharge of the river. The estimates of daily discharge

have not been published, but from them the table of monthly discharge has been prepared. In this last named table are the estimated maximum, minimum, and mean flow of the river in cubic feet per second for each month over which the record extends. Two quantities shown in this table may require explanation. In the column marked "Second-feet per Sq. Mile" are the estimated mean run-off from each square mile in the basin for each month, assuming that every small portion of the drainage area yields its proportionate part of the total flow. This quantity is obtained by dividing the mean discharge in second-feet by the area of the drainage basin.

In the column marked "Depth in Inches" is given the depth of water in inches which would result if the total quantity discharged by the river in the mouth were spread out over the whole drainage basin. In Figure 3 is shown graphically the variation in the discharge of the river during the period over which the record extends.

LIST OF DISCHARGE MEASUREMENTS OF PATUXENT RIVER, AT LAUREL.

No.	*Date.*	*Hydrographer.*	*Gage Height. Feet.*	*Discharge. Sec. Feet.*
	1896.			
1.	Sept. 18	E. G. Paul	4.60	161
2.	Nov. 25	E. G. Paul	4.40	123
	1897.			
3.	Feb. 11	E. G. Paul	5.40	184
4.	Feb. 23	A. P. Davis	8.50	612
5.	Mar. 12	E. G. Paul	4.40	155
6.	May 25	E. G. Paul	8.70	784
7.	July 13	G. H. Matthes	7.85	539
8.	July 22	E. G. Paul	13.70	6144
9.	Sept. 3	E. G. Paul	4.10	63
	1898.			
10.	Jan. 27	Paul & Matthes	5.80	359
11.	May 19	E. G. Paul	4.90	221

ESTIMATED MONTHLY DISCHARGE OF PATUXENT RIVER AT LAUREL, FOR 1898.

[DRAINAGE AREA 137 SQUARE MILES.]

Month.	Discharge in second-feet.			Run off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1898.					
January	341	94	185	1.35	1.56
February	323	110	161	1.18	1.23
March	347	90	130	0 95	1.09
April	162	94	117	0.85	0 94
May	630	78	177	1.29	1.49
June	272	59	91	0 66	0.73
July	255	6	50	0.36	0.41
August, 1-10	1,586	56	272	*1.99	*2.29

*Estimated for whole month.

DAILY GAGE HEIGHT OF PATUXENT RIVER AT LAUREL, FOR 1896.

Day.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1									4.20	4.75	3.15	4.75
2									4.00	4.30	4.35	4.85
3								4.30	4.00	3.80	3.05	4.65
4								4.30	3.50	3.20	4.40	4.70
5								4.10	4.20	3.95	4.60	4.75
6								4.20	4.50	3.75	4.65	3.95
7								4.00	4.00	3.80	4.80	4 85
8								4.00	3.30	3.75	3.25	4.75
9								3.50	3.30	3.75	4.80	4.75
10								3.90	4.30	3.80	4.45	4.70
11								4.30	2.30	3.10	4.70	4.55
12								4.10	4.50	3.90	4.50	4.65
13								4.10	2.20	3.80	4.60	3.85
14								4.30	2.90	3.90	4.45	4.60
15								4.50	4.50	3.80	3.55	4.65
16								3.60	4.70	3.80	4.60	4.60
17								4.60	4.50	3.80	4.50	4.40
18								4.00	3.75	3.10	4.40	4.55
19								4.10	4.35	3.85	4.50	4.40
20								4.60	5.10	3.90	4.50	3.20
21								4.60	3.90	4.45	4.50	4.60
22								4.40	3.75	4.30	3.00	4.50
23								3.60	3.65	4.45	4.65	4.30
24								4.40	3.80	4.40	4.30	3.85
25								4.60	3.70	3.25	4.30	4.15
26								4.60	3.80	4.60	3.15	4.25
27								4.50	3.05	4.55	4.55	4.05
28								4.50	3.70	4.15	4.20	4.25
29								4.40	3.70	3.95	5.50	4.70
30								2.70	4.85	4.10	5.00	4.65
31								4.70		3.95		4.90

DAILY GAGE HEIGHT OF PATUXENT RIVER AT LAUREL, FOR 1897.

Day.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	5.15	5.15	4.65	4.85	4.80	4.50	5.60	4.20	4.15	4.55	4.95
2	4.90	5.75	5.05	4.65	5.75	4.80	4.35	5.05	4.20	4.25	10.55	4.90
3	3.90	9.10	5.00	4.60	4.85	4.80	3.80	4.75	4.20	3.25	6.30	4.85
4	4.75	7.50	4.85	4.60	4.85	5.05	6.60	4.60	4.00	4.45	5.35	5.50
5	4.70	6.30	5.00	5.20	4.75	5.10	3.55	4.85	4.00	4.30	4.95	7.80
6	4.75	9.05	5.10	5.30	4.80	4.45	3.85	4.65	4.00	4.10	4.85	5.65
7	4.55	10.80	(a)	4.95	4.75	4.75	3.80	4.30	4.00	3.60	4.65	5.35
8	4.45	7.95	(a)	4.85	4.45	4.75	4.65	4.30	3.95	4.30	5.00	5.10
9	4.05	5.50	(a)	6.50	4.25	5.00	4.45	4.40	3.95	4.25	5.55	5.15
10	3.75	5.25	(a)	6.35	4.65	4.75	4.40	4.40	3.80	3.45	5.75	4.85
11	4.20	5.30	(a)	5.00	4.70	4.55	3.70	4.35	3.80	4.45	4.95	4.85
12	4.45	5.30	4.50	5.00	4.85	4.20	4.60	4.35	4.15	4.60	5.00	4.80
13	4.60	5.30	4.95	4.95	7.65	4.20	8.10	4.30	4.25	4.60	4.95	5.15
14	4.90	5.10	4.75	4.90	7.35	4.50	5.05	4.20	4.55	4.55	4.45	5.55
15	5.15	6.30	5.20	4.85	5.85	4.70	4.60	4.20	4.05	4.25	5.00	8.70
16	4.25	6.35	4.70	5.05	5.40	4.00	4.25	8.15	3.60	4.15	4.90	6.05
17	3.70	6.35	4.95	4.95	4.85	4.50	4.25	4.60	3.80	3.15	4.70	5.50
18	4.25	5.35	5.45	4.75	5.00	4.45	4.80	4.35	4.60	4.35	4.90	4.35
19	4.75	5.15	5.45	4.75	4.80	4.30	5.55	4.30	3.30	4.25	4.75	4.90
20	4.65	5.05	5.65	4.65	4.50	4.15	6.00	4.20	4.15	4.15	4.75	5.00
21	4.70	4.80	5.50	4.65	4 80	4.55	4.75	4.15	4.35	4.75	4.40	4.95
22	5.20	8.65	5.20	4.80	5.05	4.40	12.25	7.30	4.30	4.45	4.70	5.15
23	5.00	9.10	5.00	4.45	4.50	4.45	6.45	4.60	4.50	4.45	4.75	5.00
24	4.25	6.55	5.05	3.90	5.30	4.40	5.50	4.70	5.90	3.95	4.55	5.15
25	4.00	5.60	5.15	4.40	9.75	4.00	4.95	4.45	4.50	4.55	4.45	5.10
26	4.75	5.30	4.95	4.55	5.25	4.35	5.15	6.90	3.90	4.90	4 80	5.25
27	5.00	5.20	4.70	4.60	5.30	3.70	5.45	4.45	4.50	4.70	9.60	4.95
28	4.05	4.85	4.50	4.60	4.90	4.55	9.20	4.35	4.25	4.70	5.45	4.60
29	5.20		4.75	4.80	4.65	4.50	5.90	4.20	4.30	4.45	5.30	4.75
30	5.20		4.80	4.55	4.35	4.40	5.30	4.20	4.15	4.45	4.95	5 00
31	4.25		4 50		4.80		4.95	4.90		3.60		4.95

(a) Gage down.

DAILY GAGE HEIGHT OF PATUXENT RIVER AT LAUREL, FOR 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.10	4.90	4.65	5.00	4.40	4.40	3.80	5.15				
2	4.30	4.85	4.55	4.85	4.45	4.35	3.90	4.50				
3	4.90	5.30	4.70	4.60	4.35	4.35	3 20	3.80				
4	4.95	5.00	5.05	4.70	4.45	4.35	3.20	3.95				
5	4.85	5.00	4.70	4.80	4.50	3.90	3.95	10.15				
6	4.60	5.10	4.45	4.60	4.70	4.40	3.65	4.55				
7	4.65	5.15	4.55	4.60	5.85	4.35	3.80	4.05				
8	4.70	5.40	4.55	4.60	5.70	4.25	3.60	4.00				
9	4.75	4.90	4.60	4.45	5.60	4.35	3.55	4.80				
10	6.30	4.75	4.55	4.40	4.95	4.35	3.55	6.50				
11	5.85	4.75	4.55	4.60	7.25	4.25	3.55	(a)				
12	4.95	4.60	4.55	4.50	7.10	4.15	2.95					
13	5.00	4.65	4.40	4.55	5.95	4.20	3.05					
14	5.00	4.65	4.55	4.45	5.00	6.00	2.85					
15	6.60	4.65	4.50	4.75	4.50	4.40	3.00					
16	6.30	4.65	4.60	4.70	4.60	4.30	3.70					
17	5.55	4.50	4.70	4.35	8.40	4.25	3.50					
18	5.35	4.50	4.55	4.45	6.45	4.30	3.60					
19	5.05	5.35	4.45	4.50	4.85	4.40	3.60					
20	5.15	5.80	4.25	4.50	4.80	4.20	3.70					
21	5.50	6.45	4.50	4.45	4.70	4.10	3.75					
22	5.25	5.75	4.45	4.50	4.55	4.10	3.75					
23	5.90	5.00	4.35	4.30	4.80	3.95	3.40					
24	6.10	4.90	4.55	4.40	4.70	3.95	3.15					
25	5.10	4.85	5.70	4.80	4.50	3.85	3.55					
26	5.50	4.75	4.50	4.45	4.50	3.95	3.05					
27	5.50	4.65	4.35	4.35	4.50	3 90	5.85					
28	5.10	4.85	4.55	4.45	4.45	4.15	5.70					
29	4.85		4.65	4.65	4.10	4.10	3.95					
30	4.90		6.65	4.55	4.55	3.90	3.05					
31	4.85		5 55		4.45		3.35					

(a) Repair of bridge. Gage torn out and station discontinued.

ESTIMATED MONTHLY DISCHARGE OF PATUXENT RIVER AT LAUREL, FOR 1896-7.

[DRAINAGE AREA 137 SQUARE MILES.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square inch.	Depth in inches.
1896.					
August	160	30	117	0.87	0.98
September	203	30	98	0.72	0.80
October	185	45	98	0.72	0.83
November	247	40	129	0.94	1.04
December	181	50	140	1.02	1.18
1897.					
January	184	49	120	0.88	1.01
February	2,418	140	400	2.92	3.04
March	233	110	162	1.18	1.36
April	329	63	148	1.08	1.20
May	1,180	90	203	1.48	1.71
June	173	49	113	0.82	0.91
July	4,274	39	320	2.34	2.70
August	575	82	145	1.06	1.22
September	261	25	86	0.63	0.70
October	151	17	92	0.67	0.77
November	2,035	102	251	1.83	2.04
December	704	98	199	1.45	1.67
The year	4,274	17	187	1.36	18.33

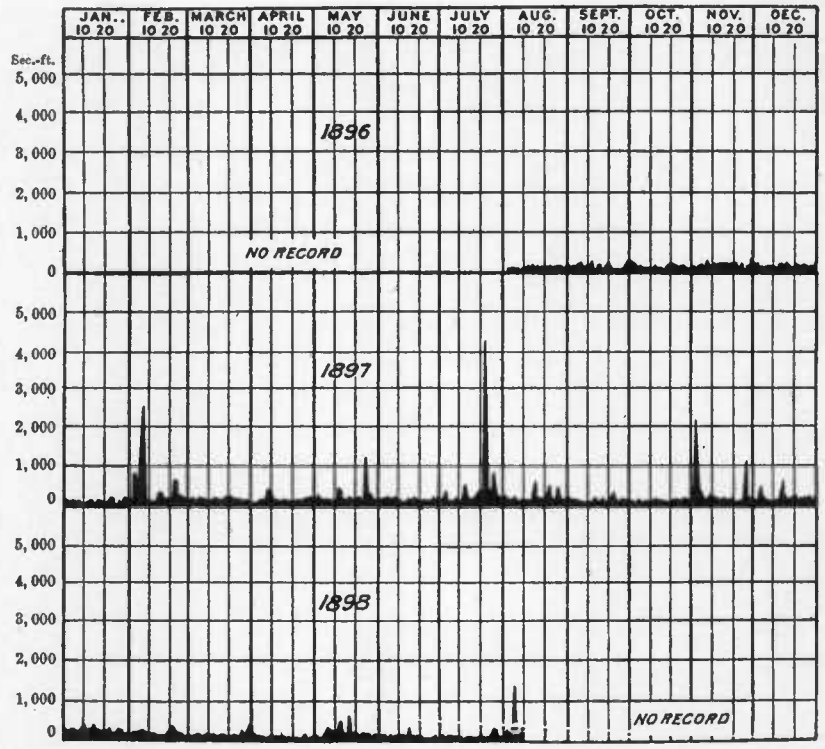


FIG. 3.—Diagram showing discharge of Patuxent River at Laurel, 1896-1898. From 20th Annual Report of U. S. Geological Survey, Part IV, page 116.

WESTERN BRANCH OF PATUXENT RIVER.

This stream lies wholly within the boundaries of Prince George's County, and drains an area of 108 square miles. Its headwaters lie to the northeast of the District of Columbia in the northern part of the county; thence the stream flows southeasterly receiving Collington Branch from the east and Charles Branch from the west and empties into Patuxent River near the middle of the eastern boundary of the county. It drains a hilly and sandy country. Below Westphalia the banks are low and subject to overflow. No water power has been reported on the stream and no discharge measurements have been made.

ANACOSTIA RIVER.

This river has its headwaters in the northern part of Prince George's and in Montgomery counties, flows southerly and southwesterly and empties into the Potomac River at Washington. Tide runs to Bladensburg. At the District line it drains an area of 147 square miles. Its basin is hilly, generally sandy and in farming lands. The most important tributaries are Indian Creek from the north, Paint and Northwest branches from the northwest, and Beaverdam branch from the east. Several water powers have been developed on these tributaries. No measurements of flow have been made.

Other less important streams of Prince George's County are tabulated below with their drainage areas:

Stream.	Drainage Area.	Locality.
Henson Creek.....	24 sq. mi.	Tidal Estuary.
Mattawoman Creek.	47 "	West boundary of Prince George's county.
Piscataway Creek..	60 "	Tidal Estuary.
Swanson	24 "	Tidal Estuary.

THE MAGNETIC DECLINATION IN PRINCE GEORGE'S COUNTY

By

L. A. BAUER.

Introductory.

Values of the magnetic declination of the needle, or of the "variation of the compass," as observed by the Maryland Geological Survey, the United States Coast and Geodetic Survey, and the Carnegie Institution of Washington at various points within the county are given in the following table:

For a general description of the methods and instruments used, reference must be made to the "First Report upon Magnetic Work in Maryland" (Md. Geol. Survey, vol. i, pt. v, 1897). In the Second Report (Md. Geol. Survey, vol. v, pt. i, 1905), the various values collected were reduced to January 1, 1900; they are now given also for January 1, 1905 and 1910, and some additional values have been added. The First Report contains an historical account of the phenomena of the compass needle and discusses fully the difficulties encountered by the surveyor on account of the many fluctuations to which the compass needle is subject. To these Reports the reader is referred for any additional details.

Meridian Line.

At the request of the State Geologist, the Superintendent of the Coast and Geodetic Survey detailed Mr. J. B. Baylor in 1900 to establish a surveyor's meridian line at the county seat, Upper Marlboro. As the grounds around the court-house were not suitable for the purpose, the line was placed on the grounds of the Academy. The line was marked by two stone posts, each bearing a brass cap lettered U. S. C. & G. S.; the south stone is 75 feet from the front

MAGNETIC DECLINATIONS IN PRINCE GEORGE'S COUNTY.

Stations.	Latitude N.	Longitude W. of Greenwich.	Date When Observed.	Magnetic Declination. (West.) Value Observed.	Reduced to 1900.0	Reduced to 1905.0	Reduced to 1910.0	Observer.
	° ′	° ′		° ′	° ′	° ′	° ′	
Cheltenham, Magnetic Observt'y.	38 44.0	76 50.5	1902.0	5 05.4	5 00			Observers, C. & G. S.
			03.0	08.2				
			04.0	11.6				
			05.0	15.7		5 16		
			06.0	20 2				
			07.0	23.8				
			08.0	28.2				
			09.0	34.1				
			10.0	39.0			5 39	
Upper Marlboro, Court House.....	38 49.0	76 45.2	1896.7	4 59.0	5 09	5 26	5 50	L. A. Bauer, Md. G. S.
Upper Marlboro, Meridian Line..	38 49.0	76 45.2	1900.5	5 05.8	5 03	5 19	5 42	Observers, C. & G. S.
Upper Marlboro, Court House,....	38 49.0	76 45.2	1903.3	5 27.6	5 16	5 33	5 58	
Mean.					5 09	5 26	5 50	
Hill	38 53.9	76 52.8	1868.8	2 51.1	4 47	5 05	5 30	Observers, C. & G. S.
Bowie.....	39 00.3	76 46.8	1908.8	6 03.1	5 28	5 46	6 11	C. C. Stewart, C. I. of W.

EXPLANATIONS.

The date of observation is given in years and tenths of; January 1, 1900, would accordingly be expressed by 1900.0 and similarly with regard to January 1, 1905, or 1910.0.

door of the Academy building and 58 feet from the fence on the street, and the north stone is on the same grounds, on the edge of the bluff.

DESCRIPTION OF STATIONS.

Cheltenham, 1902-09.—At the Magnetic Observatory of the United States Coast and Geodetic Survey, on the grounds of the House of Reformation.

Upper Marlboro, 1896 and 1903.—In the southeast corner of the court-house grounds, down in the hollow; 13.9 feet west of maple

tree and 88 feet from southeast corner of court-house; marked by a hickory tent peg driven almost flush with the ground. The mark used in 1903 was the west end of the ridge of a small frame shack about 350 yards distant, bearing 62° 36.′6 east of true south. Soil, sandy.

Upper Marlboro, 1900.—The South meridian stone is in the Academy grounds 75 feet from the front door of the Academy building and 58 feet from the fence on the street. The North meridian stone is also in the grounds of the Academy, on the edge of the bluff. From the South stone the cupola of the Southern Maryland Bank bears 42° 58′ east of true south.

The following table is reproduced from p. 483 of the First Report, without change, except that it has been extended to 1910.

CHANGE IN MAGNETIC DECLINATION AT UPPER MARLBORO FROM 1700 TO 1910.

Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.
	° ′		° ′		° ′		° ′
1700	5 17 W	1750	2 26 W	1800	0 34 W	1850	2 11 W
05	5 07 W	55	2 07 W	05	0 33 W	55	2 29 W
10	4 54 W	60	1 51 W	10	0 35 W	60	2 49 W
15	4 39 W	65	1 35 W	15	0 39 W	65	3 08 W
20	4 21 W	70	1 19 W	20	0 45 W	70	3 29 W
25	4 03 W	75	1 06 W	25	0 55 W	75	3 47 W
30	3 45 W	80	0 55 W	30	1 07 W	80	4 06 W
35	3 25 W	85	0 45 W	35	1 20 W	85	4 23 W
40	3 05 W	90	0 39 W	40	1 37 W	90	4 40 W
45	2 45 W	95	0 36 W	45	1 53 W	95	4 55 W
1750	2 26 W	1800	0 34 W	1850	2 11 W	1900	5 09 W
						05	5 27 W
						10	5 52 W

The declination is west over the county and is increasing now at the average annual rate of 5 minutes.

Hill, 1868.—In the vicinity of the Coast Survey triangulation station of 1850.

Bowie, 1908.—In an old field in the northern part of town, 350 yards (320 meters) north of the railroad station, 130 feet (39.6 meters) south of Episcopal church, 45 feet (13.7 meters) west of the path leading to Episcopal church, and 27 paces east of small willow tree on the edge of a shallow gully. The station is about in line with water tank tower and cross on Episcopal church, and is

marked by an oak stake 3 by 4 by 24 inches (7.6 by 10.2 by 61 cm.) set almost flush with the ground.

The following true bearings were determined:

Cross of Episcopal church (mark)	5° 06.′8	west of north.
Water tank tower	2 47.2	west of south.

With the aid of the figures in the preceding table the surveyor can readily ascertain the amount of change of the needle between any two dates. For practical purposes, it will suffice to regard the change thus derived as the same over the county. It should be emphasized, however, that when applying the quantities thus found in the re-running of old lines, the surveyor should not forget that the table cannot attempt to give the correction to be allowed on account of the error of the compass used in the original survey.

To reduce an observation of the magnetic declination to the mean value for the day of 24 hours, apply the quantities given in the table below with the sign as affixed:

Month.	6 A.M.	7	8	9	10	11	Noon	1	2	3	4	5	6 P.M.
	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0.1	+0.2	+1.0	+2.1	+2.4	+1.2	−1.1	−2.5	−2.6	−2.1	−1.3	−0.2	+0.2
February	+0.6	+0.7	+1.5	+1.9	+1.4	−0.1	−1.5	−2.1	−2.5	−2.0	−1.2	−0.8	−0.4
March	+1.2	+2.0	+3.0	+2.8	+1.6	−0.6	−2.5	−3.4	−3.7	−3.3	−2.3	−1.2	−0.5
April	+2.5	+3.1	+3.4	+2.6	+0.8	−2.1	−4.0	−4.1	−4.2	−3.6	−2.3	−1.2	−0.2
May	+3.0	+3.8	+3.9	+2.6	+0.1	−2.4	−4.0	−5.0	−4.5	−3.6	−2.3	−0.9	+0.1
June	+2.9	+4.4	+4 4	+3.3	+1.1	−2.0	−3.6	−4.5	−4.5	−3.8	−2.6	−1.2	−0.2
July	+3.1	+4.6	+4.9	+3.9	+1.8	−1.2	−3.4	−4.4	−4.7	−4 2	−2.8	−1.3	−0.3
August	+2.9	+4.9	+5.4	+3.7	+0.4	−2.8	−4.7	−5.1	−4.9	−3.7	−1.9	−0.6	+0.3
September	+1.8	+2.8	+3.4	+2.5	+0.3	−2.7	−4.4	−4.6	−4.2	−4.0	−1.4	−0 3	0.1
October	+0.5	+1.6	+3.1	+2.8	+1.4	−1.0	−2.7	−3.3	−3.4	−2.4	−1.3	−0.4	−0.4
November	+0.5	+1.2	+1.7	+1.8	+1.1	−0.5	−2.0	−2.7	−2.6	−1.8	−1.0	−0.2	+0.2
December	+0.2	+0.3	+0.8	+1.8	+1.8	−0.0	−1.6	−2.4	−2.3	−1.8	−1.1	−0.3	+0.1

Angle.

The angle between the true meridian line and the cupola of the Southern Maryland Bank is, at the south meridian stone:

42° 58′ E. of S.

The latitude of the Court House may be taken to be 38° 49′.0 and the longtitude 76° 45′.2 W. of Greenwich or 15′ E. of Washington. To obtain true local mean time, or solar time, subtract from Eastern or Standard time, 7 minutes.

THE FORESTS OF PRINCE GEORGE'S COUNTY

BY

F. W. BESLEY.

Introductory.

The following report of "The Forests of Prince George County" is the first contribution of the kind made by the newly created State Board of Forestry, under whose auspices all of the State forest work is now conducted. The report and accompanying forest map, showing the location and character of all forest areas, is the result of a field survey made in the summer of 1907.

The woodlands, which comprise 127,200 acres, or 41 per cent. of the total land area, consist principally of small tracts scattered rather uniformly through the County. In value of product, the forest interests are exceeded only by those of agriculture and hence constitute one of the main sources of natural wealth. Their value is further enhanced by the excellent transportation facilities, and their nearness to good markets. With the serious shortage of timber that is certain to follow the general exhaustion of the main timber supplies throughout the country, and the consequent high prices to be expected, the forest resources of this section are sure to contribute in a large measure to the future prosperity of the County.

The Distribution of the Forests.

In the early history of the county the forests constituted, by far, the larger part of the land area. Owing to the demand for tillable land the forests were rapidly reduced, until practically all of the arable land was cleared for the growing of crops. Naturally, along the Patuxent River, (where the tide of immigration first set in) the

greatest inroads were made into the forested area, until this section, known in the early settlement days as the "Forests of Prince George," has now the smallest percentage of forest land of any part of the County. For the last twenty years there has been little change. The land that was cleared prior to that time is being cultivated, and the chances are, that there will be little change in the woodland area for a long time to come. In the western part of the County the conditions are quite different. The soils of this section are more diversified and on the whole, less adaptable to the growing of agricultural crops. There are large areas of poorly drained land, also sterile sand and clay soils where pine and the oaks will thrive. Most of this land was brought under cultivation prior to 1860, for the growing of tobacco and corn. Under these exacting crops, however, much of the soil became exhausted and was allowed to grow up in brush. The change in industrial conditions following the Civil War also contributed largely to the increase in the forest areas. In the western section of the County at least, much more land has reverted to forest during the past forty years than has been cleared. The character and composition of the forest has also changed. At first there was very little pine, and there is very little now, where land has not been allowed to grow up as in the eastern part; but distributed all over the western and southern sections where land has reverted to forest, there is a large representation of pine. As a rule the land that grew oaks, poplar, and hardwoods generally was of better quality than that in which pine was found, and hence it was the hardwood land that was first cleared. As soon as any of this land was allowed to go uncultivated it was seeded in a few years by the light winged seed from the neighboring pine trees, and thus added to the increasing pine areas. In many of these young pine stands the old corn rows can still be distinguished. It is estimated that 5,000 acres of old fields have grown up to pine during the past 12 years. In the meantime other changes have followed. Because of the increasing demand for saw material, railroad ties, poles, piling, etc., and improvement in transportation facilities, the hardwoods early invited exploitation. Consequently the hardwood stands have been repeatedly culled, leaving numerous open places in the forest

FIG. 1.—VIEW SHOWING MIXED HARDWOOD FOREST, NEAR FORESTVILLE.

FIG. 2.—VIEW SHOWING MIXED OAK FOREST OF MERCHANTABLE CLASS, NEAR MARLBORO.

which have been seeded by the scrub pine. Hence in many of the open hardwood stands are found scattering pine trees of good size, giving rise to mixed forests of pine and hardwoods.

The Forest Types.

At first the forests were almost universally of the mixed hardwood type, but under the process of natural agricultural development, there has been evolved two other types, namely, the pure pine type and the hardwood-pine type.

The present condition of the forests can, therefore, be more conveniently treated under these three type classes.

MIXED HARDWOOD TYPE.

This type comprises 72 per cent. of the total woodland area, or 91,224 acres. The main features are the great variety of tree species represented, and the wide range of soils on which they occur. The composition of the type varies widely with the moisture conditions and consequently two sub-types may be distinguished—the upland and the swamp.

The Upland Sub-type is found on well-drained soils and constitutes much the larger percentage of the mixed hardwoods. There is also a larger representation of valuable species in this class than is found in the swamp-type. On the other hand, the better soils of the swamp (unless very wet) produce a thriftier growth of timber; and the greater freedom from fires, insures a sounder grade of wood. Representative stands in the two sub-types are shown in the accompanying tables.

PURE PINE TYPE.

Pure pine stands are found in the northern, southeastern and southwestern sections of the County. The two pines represented are the scrub pine and the pitch pine. The pitch pine occurs occasionally on sandy soils along the edges of swamps, but never in sufficient numbers to constitute a stand; hence as a commercial tree it may be dis-

TABLE I.

Table showing the composition of the Upland Type of Mixed Hardwoods on an average acre.

Diameter Breast High Inches	White Oak	Black Oak	Dog-wood	Hickory	Spanish Oak	Chestnut	Black Gum	Chestnut Oak	Red Gum	Beech	Scrub Pine	Red Maple	Pitch Pine	Holly	Cedar	Post Oak	Persim-mon	Tulip
2	8.50	12.75	11.25	5.25	3.25	2.50	2.00	.....	.50	1.00	.50	.25	.....	.25	.50	.....	.25	.....
3	3.50	6.25	4.50	1.50	1.75	1.75	.25	1.00	1.25	1.00	.75	.50	.....	.25	.....	....	.....	.....
4	1.75	3.50	1.25	2.50	1.25	1.00	1.25	.75	.50	.....	.....	.....	.....	.....	.....	.....	.....	.25
5	1.25	2.25	.50	1.00	.....	1.25	.50	.75	.....	.50	.....	.25	.50	.....	.....	...	.....	.....
6	1.50	.50	.....	1.75	1.25	.50	.75	.75	1.00	.....	.50	.....	.....	.....	.....	.....	.....	....
7	2.00	2.00	.....	.75	.25	.50	.75	.....	.25	.25	.....	.....	.....	.....	.....	.....	.....	.....
8	2.50	1.25	.....	.....	.....	.....	.25	.....	.....	.....	.50	.....	.....	....	.....	.25	.....	.....
9	.75	.50	.....	.50	.....	.....	.25	.25	.....	....	.....	.....	.....	.....	.....	.25	.....	.....
10	4.50	.....	.....	.25	.....	.25	.25	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....
11	1.75	.....	.....	.25	.25	.....	.....	.25	.....	.....	.....	.....	.....	.....	.....	....	.....	.....
12	1.50	.25	.....	.25	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	1.50	1.00	.....	.....	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	.....	.....
14	1.00	1.50	.....	.25	.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	.50	.75	.....	.25	.50	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	.25	.50	.....	.25	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	1.00	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	.25	.....	.....	.....	.....	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	.25	.....	.....	.....	.....	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	34.25	33.75	17.50	14.25	9.75	8.50	6.25	3.75	3.50	2.75	2.25	1.00	.50	.50	.50	.50	.25	.25
Per cent	24.39	24.14	12.53	10.19	6.97	6.07	4.38	2.69	2.52	1.98	1.62	.72	.36	.36	.36	.36	.18	.18

TABLE II.

Table showing the representation of species of the Swamp Type of Mixed Hardwoods on an average acre.

Diameter Breast High Inches	Red Maple	Pin Oak	Beech	Birch	Black Gum	Red Gum	White Oak	Willow Oak	Ash	Tulip	Sycamore	Hickory	Ironwood	Elm	Black Oak
2	14.25	.50	4.75	.50	5.00	1.25	2.50				.75	.25			
3	6.50	2.00	5.25	1.75	3.25	1.00		1.00	1.50			.25	.50	.25	
4	4.25	2.00	3.00	2.00	2.25	1.00	.75	.25	.50		.25	.50	.25		
5	2.75	5.00	1.25	2.25	1.50	1.00		.50	.75	.25	.25		.25		
6	3.75	3.25	.75	1.75	.25	1.25	.50	.75	.50		.25	.50		.25	
7	1.50	2 50	.50	1.00	.75	1.00	.75	.50	.50	.50	.25				
8	1.00	2.25	.25	1.00		.75	.75	.25	.25		.50			.25	
9	.50	3.75		1.25	.25	1.00									
10	.25	4.25	.75	1.00	.50	.50				1.00					
11	.50	1.75	.25	1.25	.25		.50	.25		.50		.50			.25
12		1.75		.75			.25								
13		.50				.75	.25							.25	
14		1.00					50								.25
15		.25		.25		.50	25								.50
16						.25		.50							
17										25					
Totals	35.25	30.75	17 00	14.75	14.00	10.25	7.00	4.00	4.00	2.50	2.25	2.00	1.00	1.00	1.00
Per Cent	24.02	20.97	11.58	10.05	9 54	6.98	4.77	2.73	2.73	1.70	1.53	1.36	.68	.68	.68

regarded. The pine forests, therefore, consist practically of pure scrub pine. There are 23,755 acres of this type or eighteen per cent. of the total land area. Of this amount 16,800 acres is of merchantable size (4″ and over in diameter), and 6,975 acres consists of young stands of sapling size that have come in, for the most part, on abandoned fields. This type is fairly represented by the average acre stand, shown in the following table:

TABLE III.

PURE PINE TYPE.

Table showing representation of species 2 inches and over in diameter on one acre.

Average of 4 acres (10 sample plots).

Diameter Breast High Inches	Scrub Pine	Cedar	Black Oak	White Oak	Black Gum	Hickory	Red Maple
2	98.13	12.50	6.87	6.12		.63	.63
3	103.88	11.87	7.50	.63			
4	77.35	3.13					
5	28.00				.63		
6	33.63						
7	29.38						
8	28.13						
9	13.75						
10	12.50				.63		
11	11.25						
12	3 13						
13	5.62						
14	2.50						
Totals	447.25	27.50	14.37	6.75	1.26	.63	.63
Per Cent	89.73	5.50	2.98	1.31	.24	.12	.12
4 Inches and Over	245.24	3.13			1.26		
Per Cent	98.25	1.25			.50		

HARDWOOD-PINE TYPE.

There are large areas where scrub pine is found in mixture with the hardwoods in sufficient amount to form a separate type, called the hardwood-pine type. This type aggregates 12,199 acres, or 10 per cent. of the total woodland area. Pine constitutes only about

FIG. 1.—VIEW SHOWING A SCRUB PINE FOREST, NEAR SEABROOK.

FIG. 2.—VIEW SHOWING PULPWOOD FOR SHIPMENT, BRANDYWINE STATION, POPE'S CREEK BRANCH, P., B. AND W. R. R.

12 per cent. of the stand, and consists of individual trees scattered here and there. It appears that the pine, in most cases, started in openings made by excessive cuttings in the hardwood stand, and with suitable soil conditions and plenty of light and growing space, it has been able to hold its own. When the present stand is cut, the pine will probably not appear as any considerable part of the succeeding stand because of the greater reproductive power, and more persistent growth of the hardwoods. In general, the hardwood-pine type may, therefore, be regarded as only a temporary one. The representation of species by diameter classes for the type is shown in an average acre stand in Table I.

The Stand of Timber and Its Value.

For the purpose of securing an estimate of the standing timber in the county, as well as the composition and character of the present growing stock, the woodlands were mapped and classified in six different classes, namely, merchantable hardwoods, merchantable pine, culled hardwoods, hardwood saplings, and pine saplings. The area, stand, and value of saw timber, and pine cordwood for each district, is given in Table V.

MERCHANTABLE HARDWOOD.

It is shown, by the table, that the merchantable hardwood class constitutes but 4 per cent. of the wooded area, but in value of stand, it ranks second. The bulk of it is found in the districts of the eastern section where the soil is of better quality (see map). The merchantable hardwoods have an estimated stumpage value of $4 per thousand board feet, which is higher than for any other class. The higher rate is due to the fact that the timber has been less severely culled and is therefore, of better quality; and also because of the heavier stand the logging expenses are less per thousand feet. The representation of species, by diameter classes for the average acre is indicated in Table VI.

It will be observed, from the table above, that while inferior species, such as dogwood and ironwood, constitute a large per cent. of the stand in point of numbers they are of little commercial importance because they seldom grow above the size of underbrush. The

TABLE IV.

CULLED HARDWOOD AND MERCHANTABLE PINE TYPE.

Table showing representation of species 2 inches and over in diameter on one acre.

Average of 10 acres (23 plots).

Diameter Breast High Inches	White Oak	Black Oak	Pine	Spanish Oak	Red Gum	Hickory	Blaek Jack	Black Gum	Chestnut	Cherry	Maple	Dog-wood	Cedar	Ash	Holly	Red Oak	Sycamore
2	47.33	35.55	2.45	5.32	8 89	17 34	6 22	6 22	.33	3.34	4.45	1.56	1.78	1.11	.89		
3	34.89	21.78	2.00	4.00	4 00	2.00	5.33	5.34	.45		.22	1.11	.22				
4	34.21	7.11	5.11	7.78	4.00		2.67		.45	3.33	.22						
5	18.33	16.67	8.89	9.56	1.11	.11	.89		.67		1.11						
6	12.12	6.11	7.11	8.23	1.33		.89	.89	.67							.11	.23
7	13 00	4.67	5.23	3.11	2.45	.11		.22	.78								
8	10.11	1.22	8.22	7.34	.11				.67							.11	
9	3.00	1.11	10.11	2.22					.89								
10	.11	.11	7.78	2.00		.11			.44								
11	2.33		2.00	1.11					.44							.11	
12	.34		.44					1.11	.56								
13	2.67		.22	.89					.67								
14	.22	.22	.11						.33								
15	.11		.11						.44								
16	.45			22					.33								
17									.22								
18	.22				.22				.33							.11	
19									.11								
20	.33								.22								
21									.22								
22									.11								
23									.11								
24				.22					.11								
25									.11								
27									.11								
30									.11								
Total	179.77	94.55	59.78	52.00	22.11	19.67	16.00	13.78	9.88	6.67	6.00	2.67	2.00	1.11	.89	.44	.23
Per Cent	36.86	19.38	12.26	10.66	4.54	4.04	3.28	2.83	2.03	1.37	1.23	.55	.41	.23	.19	.09	.05

TABLE V.

Stand of saw timber and pine cordwood arranged by districts.

District	Merchantable Hardwoods				Merchantable Pine				Culled Hardwoods				Culled Hardwoods and Merchantable Pines						Hardwood Saplings		Pine Saplings	
	Area, Acres	Percent. of total woodland in District	Stand, 10 in. and over, M. bd. ft.	Value at $1 per M.	Area, Acres	Percent. of total woodland in District	Stand, 4 in. and over, Cords	Value at 60 cents per Cord	Area, Acres	Percent. of total woodland in District	Stand, 10 in. and over, M. bd. ft.	Value at $2.50 per M.	Area, Acres	Percent. of total woodland in District	Stand, 10 in. and over, M. bd. ft.	Stand, 4 in. and over, Cords	Value at $2.00 per M.	Value at 40 cents per Cord	Area, Acres	Percent. of total woodland in District	Area, Acres	Percent. of total woodland in District
Vansville I.	69	1	252	$ 1008	2867	23	38765	$23259	4294	34	4741	$11853	2048	16	852	8055	$1704	$3222	2144	17	1069	9
Bladensburg II.	...	...	.....	.....	1401	31	18950	11370	1837	41	2028	5070	1001	22	416	3936	832	1574	66	2	175	4
Marlboro III.	276	7	1007	4028	.....	...	.....	.....	3857	93	4258	10645	.....	....	....	.....	....	.....	....	....	....	....
Nottingham IV.	1062	15	3866	15464	320	4	4326	2596	5651	78	6240	15600	....	....	....	.....	....	.....	31	....	207	3
Piscataway V.	471	3	1715	6860	3354	20	45341	27205	9165	53	10120	25300	2925	17	1217	11510	2434	4604	163	1	1050	6
Spaulding's VI.	.....	....	.....	.....	63	1	850	510	3757	61	4149	10372	597	9	248	2348	496	939	1280	21	502	8
Queen Anne VII.	1024	15	3726	14904	12	....	169	101	5536	82	6112	15280	63	1	26	247	52	99	19	1	69	1
Aquasco VIII.	75	1	273	1092	1664	18	22497	13498	6854	72	7568	18920	100	1	42	395	84	158	157	2	597	6
Surratt's IX.	81	1	296	1184	1106	13	14952	8971	5478	66	6041	15113	.....	....	.....	.....	.....	.....	960	12	704	8
Laurel X.	19	1	67	268	188	6	2544	1526	1690	56	1865	4662	245	10	102	965	204	386	646	21	195	6
Brandywine XI.	63	1	229	916	1434	9	19382	11629	11808	70	13040	32600	239	1	99	939	198	376	2541	15	749	4
Oxon XII.	....	...	.....	.....	207	5	2803	1682	3347	90	3688	9220	.....	...	.....	.....	.....	.....	101	3	81	2
Kent XIII.	239	3	869	3476	1702	23	23016	13810	4512	61	4982	12455	791	11	329	3112	658	1245	....	....	145	2
Bowie XIV.	395	3	1441	5764	1898	14	25656	15393	5933	42	6548	16370	4051	29	1686	15940	3372	6376	477	3	1232	9
Melwood XV.	440	11	1610	6440	113	3	1523	914	3232	81	3570	8925	.....	.....	.....	.....	.....	.....	19	1	182	4
Hyattsville XVI.	338	16	1230	4920	470	22	6360	3816	1117	54	1234	3085	139	7	58	547	116	219	....	....	18	1
Totals.	4552	4	16581	$66324	16799	13	227134	$136280	78068	61	86188	$215470	12199	10	5075	47994	$10150	$19198	8604	7	6975	5

NOTE.– Doyle rule was used in scaling sample plots. A liberal allowanco was made for unsoundness.

TABLE VI.—MERCHANTABLE HARDWOOD CLASS.

Table showing representation of species 2 inches and over in diameter on one acre.

Average of 4.2 acre (11 sample plots).

Diameter Breast High Inches	Hickory	Chestnut	Dogwood	Ironwood	Beech	White Oak	Yellow Poplar	Black Oak	Red Gum	Spanish Oak	Pin Oak	Black Gum	Red Maple	Red Oak	Birch	Willow Oak	Others
2	8.81	7.86	17.14	8.09	6.43	1.90	1.66	2.86	.71	3.57		.71	1.19	.48			.96
3	3.10	4.76	4.05	7.62	4.76	.48	1.43					1.19	.48	.24			.24
4	2.62	3.33	2.86	3.81	3.33	.71	2.14	1.90	.71	1.43		.95	.24	.48		.48	1.91
5	2.38	2.86		3.33	.95	.24	1.43	2.14	.71	2 14		.48	.24	.24			.48
6	1.66	1 90		.48	1.19	1.19	1.66		.95	.71		.48	.71	.24			.24
7	2.62	.71			.24	1.90	.71	.71	.48	.71	1.19	1.19	.48	.24			
8	.71	.24			.71	.71	.48	.71	.95		.71	.71	.24				.48
9	1.43	.24			.24	.71	1.19	.24	.95		.95	.48			.48		
10	1.19				.71	2.14	.95		.71		.95				.95		
11	.95				.95	.71	.48	.71	.95		1.90		24			.48	.48
12	.95	.48				.71	1.90		.48	.71	1.43			.24			
13						.24	.95	1.19	2.38			.48		.95			.24
14		.24				.71	.48	.71	.95		.48			.71			
15		.24			.48	.95	.24	.95	.48		.95	.24		.24	.95		
16	.71	.24				.71		.71	.48			.48	.24				
17		.24				.48	.48	.48	.48								
18		.24				.24		.71			.48	.24					
19						.95											
20												.48		.24			
21		.24							.48				.48				
22		.24											.71				
23						.71	.24										
24					.24	.71											
25		.24															
26																	
27					.48												
28							.24							.24			
29						.71											
31		.24															
36		.24															
Total	27.13	24.78	24.05	23 33	20.71	17.81	16 66	14.02	12.85	9.27	9.04	8.11	5.25	4.54	2.38	.96	5.03
Per Cent	12.02	10.96	10.64	10.32	9 17	7.91	7.38	6.22	5.69	4.11	4.00	3 58	2 32	2.00	1.05	.42	2.21
10 in. and over in diameter	3.80	2.88			2.86	9.97	5.96	5.46	7.39	7.71	6.19	1.92	1.67	2 62	1.90	.48	1.72
Per Cent	6 96	5.28			5.24	18.27	10.92	10.02	13.54	1.30	11.35	3.54	3.12	4.80	3.48	.88	1.30

FIG. 1.—VIEW SHOWING METHOD OF HAULING PILES, NEAR SUBRATTSVILLE.

FIG. 2.—VIEW SHOWING YELLOW POPLAR LOGS FOR EXPORT, MULLIKIN STATION, POPE'S CREEK BRANCH, P., B. AND W. R. R.

stand of saw timber 10″ and over in diameter as shown in the lower line of the table is made up principally of white oak, red gum, pin oak, yellow poplar, black oak, hickory, chestnut, and beech. The average stand is 3,642 board feet per acre, and the area covered by this class is 4,552 acres, giving a total stand of 16,580,022 board feet. This represents very nearly the amount of timber that is immediately available, and indicates where the stand is sufficiently heavy to warrant logging operations.

MERCHANTABLE PINE.

The merchantable pine class, constitutes 13 per cent. of the wooded area, and exceeds that of the merchantable hardwoods over twofold. Most of it is found in the northern and southern districts, with but little in the central part of the county. The three leading centers for merchantable pine are Lanham, Piscataway and Cedarville. The average stand per acre including all trees 4 inches and over in diameter as merchantable, is 13.52 cords. The total stand of merchantable pine on the 16,799 acres of the class, is therefore, 227,134 cords. This valued at 60 cents per cord, standing, gives a stumpage value of $136,280. The pine with its associated species in this type is shown in Table III.

CULLED HARDWOOD.

This class of stand represents the mixed hardwood forests that have been culled severely until there is little left in the way of saw timber. The average stand per acre for the 70,868 acres of the class is 1,104 feet, board measure, giving a total stand of 86,188,000 board feet. The stumpage value of the stand at $2.50 per M. is $215,470. The culled hardwoods are more evenly distributed over the county than any other class and exceed in area all the other five classes combined, representing 61 per cent. of the total forest area. The composition of an average acre of the stand is shown in the accompanying table.

CULLED HARDWOOD AND MERCHANTABLE PINE.

This type of forest constitutes 10 per cent. of the forested area. The stand per acre is 416 board feet of saw timber, and 3.94 cords

TABLE VII.

CULLED HARDWOOD CLASS.

Table showing representation of species 2 inches and over in diameter on one acre.

Average of 13.8 acres (35 sample plots).

Diameter Breast High Inches	White Oak	Red Maple	Beech	Pin Oak	Red Gum	Black Oak	Black Gum	Scarlet Oak	Chestnut Oak	Spanish Oak	Birch	Ash	Hickory	Chestnut	Dog Wood	Willow Oak	Post Oak	Tulip	Cedar	Black Jack	Sycamore	Scrub Pine	Red Oak	Holly	All Others
2	22.33	16.22	9.75	.58	5.53	8.33	9.86	3.33	1.53	2.83	.43	....	3.33	.43	3.55	.10	1.01	.36	2.32	.65	1.31	.29	.22	.43	.51
3	13.34	7.15	9.22	1.66	6.96	3.84	3.00	1.74	3.63	2.83	1.52	2.39	1.60	.22	2.03	1.30	1.45	...	.65	.80	....	65	....	.58	.65
4	9.23	3.94	5.77	2.32	4.59	3.50	3.27	2.75	3.62	1.67	1.52	1.09	1.38	.29	.29	.73	1.30	.43	....	.65	....	....	.22	.15	.43
5	8.26	2 92	3.47	5.65	3.60	1.22	1.96	1.09	3.34	.73	1.74	1.52	.36	.43	.29	.80	.72	.07	....	.36	....	.07	.29	....	.15
6	6.16	3.36	1.90	3.99	3.58	3.53	1.23	2.83	1.81	1.30	1 52	1.30	1.09	.43	....	.53	.29	.10	....	.29	.43	.43	.15	....	....
7	4.63	1.47	1.54	2.39	1.60	2.13	1.31	2.61	1.45	1.01	.65	1.31	.07	.80	....	.44	.15	.53	....	.14	.43	.15	.21	....	.07
8	3.84	1.04	1.03	1.95	1.33	1.55	.36	1.30	.21	.58	.65	1 09	.15	.65	....	.29	....	.07	....	....	.43	.29	.07	....	....
9	1.01	.60	.53	3.48	1.57	.87	.58	.80	.29	.....	1.09	....	....	.65	...	.73	....	.10	.07	...	....	....	.07	....	....
10	3 69	.21	.93	4.27	.....	.80	.29	1.16	.29	.....	.80	....	....	.65	....	.29	.15	.96	....	....	....	.36	.07	....	....
11	2.63	.55	.31	1.45	.49	.43	.36	.51	.29	.29	1.09	.43	.43	.51	....	.24	....	.43	..	....	....	....	.07	....	....
12	1.95	.10	.07	1.74	.58	.27	.....	.29	.....	.....	.65	....	....	.43	....	....	....	.10	...	...	....	....	.07	...	...
13	1.37	.....	.16	.65	.43	.22	.....	.22	.....	43	.....	....	....	.51	....	15	....	....	....	....	....	....	.15	...	.43
14	.86	.....	.....	.65	.07	.97	.....	.....	.....	.29	.....	....	.07	.44	...	17	....	....	....	....	....	....	....	....	....
15	1.01	.....	.....	.35	.29	.70	.....	.....	....	.29	.16	....	.07	.29	..	....	....	....	....	....	....	....	.07	....	....
16	.36	.....	.....	.00	.21	.29	.....	.....	.....	.29	.....	....	....	.22	....	.10	...	....	....	....	....	...	....	....	....
17	.....	.....	.....	.....	.....	.36	.....	.....	.....	.....	.....	....	....	.22	....	....	....	.15	....	..	....	....	....	....	....
18	.58	.....	....	.09	.....	.....	.....	.....	.....	.....	.....	....	....	.15	....	....	....	..	....	....	....	....	....	....	....
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.15	....	....	....	....	....	....	....	....	....	....	....
20	.....	....	.07	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.07	....	....	....	....	....	....	....	....	.07	...	....
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.15	...	...	....	....	....	....	....	....	....	....	....
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.07	....	....	....	....	....	....	....	....	....	....	....
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.07	....	....	....	....	....	....	....	....	....	....	....
25	.29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.07	....	....	....	....	....	....	....	....	....	....	....
27	.....	.....	.15	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.....	....	....	....	....	....	....	....	....	....	....	....
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	.07	....	....	....	....	....	....	....	....	....	....	....
Total	81.54	37.51	34.90	31.31	30.83	29.01	22.22	18.63	16.46	12.54	11.82	9.13	8.55	7.97	6.16	5.87	5.07	3.30	3.04	2.89	2.60	2.24	1.73	1.16	2.24
Per Cent.	20.96	9.65	8.98	8 05	7.93	7.46	5.72	4.80	4.23	3.23	3.04	2 35	2.20	2.05	1.59	1.51	1.30	.85	.78	.74	.67	.58	.45	.30	.58
10 in. and over	12.74	.86	1.69	9.29	2.07	4 04	.75	2.18	.58	1.59	2.70	.43	.57	4.07	....	.95	.15	1.64	....	....	....	.36	.50	....	.43
Per Cent.	26.78	1.81	3.55	9.52	4.35	8.49	1.57	4.58	1.22	3.34	5.67	.90	1.20	8.55	....	2.00	.32	3.44	....	....	....	.76	1.05	....	.90

of pine wood, with a combined stumpage value of $2.40 per acre. Large tracts of this class of timber are found in Bowie, Vansville, Bladensburg, and Piscataway Districts. Table IV shows the representation of species by diameter classes on an average acre.

TABLE VIII.

Tabular summary of standing timber and its value.

District	Area of District, Acres	Total Woodland in District, Acres	Per Cent. of Woodland	Total Stand		Stumpage Value		Total
				Saw Timber M bd. ft.	Pine Cordwood Cords	Saw Timber	Value Pine Cordwood	
Vansville I....	23,083	12,492	54	5,845	46,820	$14,565	$26,481	$41,046
Bladensburg II..	8,806	4,481	51	2,444	22,886	5,902	12,944	18,846
Marlboro III...	15,360	4,134	27	5,265	0	14,673	0	14,673
Nottingham IV.	24,678	7,272	29	10,106	4,326	31,063	2,596	33,659
Piscataway V...	31,149	17,127	58	13,052	56,851	34,594	31,809	66,403
Spaulding's VI..	14,605	6,199	42	4,397	3,198	10,868	1,449	12,317
Queen Anne VII.	29,581	6,723	23	9,864	416	30,236	200	30,436
Aquasco VIII...	19,866	9,448	48	7,883	22,892	20,096	13,656	33,752
Surratt's IX....	17,683	8,329	47	6,341	14,952	16,297	8,971	25,268
Laurel X.....	7,885	2,982	38	2,034	3,509	5,135	1,912	7,047
Brandywine XI.	28,595	16,833	59	13,368	20,321	33,714	12,005	45,719
Oxon XII.....	12,122	3,736	31	3,688	2,803	9,220	1,682	10,902
Kent XIII.....	21,645	7,389	34	6,180	26,128	16,589	15,054	31,643
Bowie XIV.....	24,742	13,987	57	9,675	41,596	25,506	21,770	47,276
Melwood XV...	19,571	3,986	20	5,180	1,523	15,365	914	16,279
Ilyattsville XVI.	7,501	2,082	28	2,522	6,907	8,121	4,035	12,157
Totals.....	306,872	127,200	41	107,838	275,128	$291,944	$155,478	$447,422

HARDWOOD SAPLINGS.

This class of hardwoods represents the young growth under 4 inches in diameter and, therefore, contains no merchantable mate-

rial. Where hardwood saplings occur, it is an indication that close cutting has been practiced, especially in the cutting of cordwood, resulting in a young sprout growth. The total area of this kind of growth is 8,604 acres, or 7 per cent. of the total forest area.

PINE SAPLINGS.

Young stands of scrub pine, in which the average diameter of the trees is under 4 inches, are designated as pine saplings. This class comprises 6,975 acres, or 5 per cent. of the total woodland area. The area of pine saplings in each district is a fair indication of the amount of land formerly cultivated, but which has reverted to woodland within the past fifteen years.

The stand and value of saw timber and pine cordwood is arranged by districts in the accompanying tabular summary.

The accompanying table shows a total stand of 107,842,000 feet, board measure, of saw timber in the county, having a stumpage value of $291,944. This includes all trees 10 inches and over in diameter measured at breast height (or 4½ feet from the ground), and is equivalent to a diameter of 12 inches and over on the stump.

The total stand of pine cordwood is 275,128 cords, representing a stumpage value of $155,478. This includes all pine trees 4 inches and over in diameter breast height (4½ feet from the ground) or about 5 inches and over on the stump. The pine found in the county is almost exclusively the scrub pine which seldom attains the size of saw timber, and hence practically its entire use is for cord or pulp wood. The stand is therefore expressed in cords. The value of the stand if based on stumpage prices rather than on the market prices of the delivered product, because the latter varies so with local conditions of labor, transportation, nearness to shipping points, markets, etc. Under prevailing prices, however, it is estimated that the total available supply of saw timber would represent a value of $1,295,000 delivered at the nearest shipping point, and that of pine cordwood would amount to $850,000, making a total of $2,100,000 as the value of the present merchantable stand, cut and delivered.

The timber that would go into poles, piling, and railroad ties is not separated from the saw timber in the estimation of the stand,

because the amount so used represents a relatively small part of the output.

List of Native Tree Species.

Conifers.

	Common Name.	*Botanical Name.*
1.	Scrub Pine	*Pinus virginiana* (Mill.).
2.	Pitch Pine	*Pinus rigida* (Mill.).
3.	Shortleaf Pine	*Pinus echinata* (Mill.).
4.	Red Cedar	*Juniperus virginiana* (Linné).

Hardwoods.

	Common Name.	*Botanical Name.*
5.	Butternut	*Juglans cinerea* (Linné).
6.	Black Walnut	*Juglans nigra* (Linné).
7.	Butternut Hickory	*Hicoria minima* (Marsh) Britton.
8.	Mockernut Hickory	*Hicoria alba* (Linné) Britton.
9.	Pignut Hickory	*Hicoria glabra* (Mill.) Britton.
10.	White Willow	*Salix alba* (Linné).
11.	Black Willow	*Salix nigra* (Marsh).
12.	Largetooth Aspen	*Populus grandidentata* (Michx.).
13.	River Birch	*Betula nigra* (Linné).
14.	Sweet Birch	*Betula lenta* (Linné).
15.	Blue Beech	*Carpinus caroliniana* (Walt.).
16.	Beech	*Fagus atropunicea* (Marsh) Sudw.
17.	Chinquapin	*Castanea pumila* (Linné) Mill.
18.	Chestnut	*Castanea dentata* (Marsh) Borkh.
19.	White Oak	*Quercus alba* (Linné).
20.	Post Oak	*Quercus minor* (Marsh) Sargent.
21.	Overcup Oak	*Quercus lyrata* (Walt.).
22.	Chestnut Oak	*Quercus prinus* (Linné).
23.	Swamp White Oak	*Quercus platanoides* (Lam.) Sudw.
24.	Cow Oak	*Quercus michauxii* (Nutt.).
25.	Red Oak	*Quercus rubra* (Linné).
26.	Scarlet Oak	*Quercus coccinea* (Muench).
27.	Black Oak	*Quercus velutina* (Lam.).
28.	Spanish Oak	*Quercus digitata* (Marsh) Sudw.
29.	Pin Oak	*Quercus palustris* (Muench).
30.	Black Jack Oak	*Quercus marilandica* (Muench).
31.	Shingle Oak	*Quercus imbricaria* (Michx.).
32.	Willow Oak	*Quercus phellos* (Linné).
33.	Slippery Elm	*Ulmus pubescens* (Walt.).

34. White Elm.....*Ulmus americana* (Linné).
35. Hackberry .....*Celtis occidentalis* (Linné).
36. Red Mulberry.....*Morus rubra* (Linné).
37. Sweet Magnolia.....*Magnolia glauca* (Linné).
38. Yellow Poplar.....*Liriodendron tulipifera* (Linné).
39. Pawpaw .....*Asimina triloba* (Linné) Dunal.
40. Sassafras .....*Sassafras sassafras* (Linné) Karst.
41. Witch Hazel.....*Hamamelis virginiana* (Linné).
42. Red Gum.....*Liquidambar styraciflua* (Linné).
43. Sycamore .....*Platanus occidentalis* (Linné).
44. Service-berry .....*Amelanchier canadensis* (Linné) Medic.
45. Scarlet Haw.....*Crataegus coccinea* (Linné).
46. Washington Haw.....*Crataegus cordata* (Mill).
47. Black Cherry.....*Prunus serotina* (Ehrh.).
48. Red-bud .....*Cercis canadensis* (Linné).
49. Locust .....*Robinia pseudacacia* (Linné).
50. Holly .....*Ilex opaca* (Ait.).
51. Silver Maple.....*Acer saccharinum* (Linné).
52. Red Maple.....*Acer rubrum* (Linné).
53. Basswood .....*Tilia americana* (Linné).
54. Dogwood .....*Cornus florida* (Linné).
55. Black Gum.....*Nyssa sylvatica* (Marsh).
56. Persimmon .....*Diospyros virginiana* (Linné).
57. Black Ash.....*Fraxinus nigra* (Marsh).
58. White Ash.....*Fraxinus americana* (Linné).
59. Red Ash.....*Fraxinus pennsylvanica* (Marsh).
60. Nannyberry .....*Viburnum prunifolium* (Linné).

The Important Commercial Trees.

The Oak.—Of the fourteen species of oak found in the county only white, red, black, and pin oak are of much importance. Of these, white oak is more common as well as being of much greater value. It occurs on all soils, and is frequently found in almost pure stands. Large trees are in demand for saw timber, the best of which go into bridge plank, car stuff and wagon stock; smaller trees are cut into railroad ties.

Red oak saw timber from large, sound, straight-grained trees makes excellent furniture wood and is substituted to some extent for white oak. Only occasional trees are found, however, that are of sufficiently good quality to produce valuable timber. Since it is a much

faster growing tree than the white oak, and is one of the valuable woods, it is a species to encourage in the forest.

Black Oak is usually found on the upland soils where it makes a slow growth and does not produce as good lumber as the white oak, or red oak (though it is often classed as red oak on the market). Its principal use is local, and most of it goes into framing material and rough lumber.

Pin oak is a swamp tree, and in such localities it should be encouraged as it maintains a rapid rate of growth and makes straight, clean poles, and clear logs, when properly managed. Its principal use is for sawed lumber and for piling. On the lumber market it passes for red oak.

The Chestnut.—The chestnut is a rapid growing tree that furnishes desirable wood, useful for many purposes. Tall straight trees up to 20 inches in diameter are in demand for telephone and telegraph poles. Large trees, as a rule, suffer from "wind shake" and do not produce first class material. When sound, however, such trees are cut into dimension stuff, boards, or sawed railroad ties. The smaller trees are largely used for hewed railroad ties, and for fence posts. In growing timber for quicker returns, the chestnut is the most valuable species in the county. It is, therefore, a good tree to encourage on the farmer's woodlot.

The Yellow Poplar.—This is one of the most valuable timber trees and is found scattered sparingly through the forest, particularly in the deep, moist, well-drained soils. It is a rapid grower, similar in this respect to the chestnut, and attains a large size. Large trees bring good prices for saw timber, and smaller ones are largely utilized for pulpwood. Yellow poplar will not come in under the shade of other trees, and consequently it is being gradually crowded out of the forest. It is one of the best native species for commercial planting on good soils.

The Scrub Pine.—Of the four pines that are found in the county, the scrub pine is the only one of wide distribution. It quickly comes in old fields wherever there are seed trees in the vicinity, and for this reason it serves a valuable purpose in producing a crop of wood

on land that might otherwise be unproductive. The tree does not ordinarily attain the size of saw timber, but it has a wide use for cordwood, and much of it now goes into wood pulp.

The Red Gum.—This species is found in the swampy locations, particularly along the Patuxent River, where it often occurs in pure stands. Until recent years red gum had little value, but now it is used largely for veneer in the manufacture of berry and peach baskets, and is also used for wood pulp. For veneer trees over ten inches in diameter are required, while for pulpwood, smaller material is merchantable.

The Hickory.—Hickory is abundant in the upland forests, but it has a limited commercial use. The best butt cuts are used for wheelwright stock, but there is not much shipped out of the county. It is a slow growing tree and under prevailing forest conditions is not likely to increase in importance in the future stands of timber.

The Red Cedar.—The red cedar seldom attains normal development in the forest in competition with other trees because of its slow growth and intolerance of shade. It is, however, an important tree in old fields, and along fence rows, where it finds ideal conditions of growth. The wood of the red cedar exceeds all other native woods of the county in durability and is hence extensively used for fence posts. Its greatest competitors for such use are locust and chestnut, which are much more rapid growers, but owing to their liability to insect attacks and fungus diseases from which the cedar is apparently immune, it easily maintains its supremacy.

The Present Use of the Forests.

LUMBER.

The lumber production of the county for 1907 was about 4,000,000 feet, board measure. About 75 per cent. of the output was used locally. Nearly all of the original stands have been lumbered, and what is left is being cut by small mills, of which there are about fifteen now in operation. The present annual cut is about equal to the yearly growth of the forest, and can be maintained for an indef-

FIG. 1.—VIEW SHOWING YOUNG FOREST, RECENTLY BURNED OVER, NEAR SPRINGFIELD.

FIG. 2.—VIEW SHOWING CULLED FOREST AND WASTE IN LOGGING, NEAR SURRATTSVILLE.

inite time; or greatly increased, under conservative methods of lumbering and of forest management. Oak is the principal species cut, and of this, white oak constitutes much the larger share. Good quality of white oak brings $18 per M. at the mill. The poorer grades sell for about $15 per M. White oak car stuff of first quality brings $28 per M. delivered at the railroad. Most of the white oak is cut into bridge plank and framing material. Some of the best of it goes into lumber for freight cars, and some into wagon stock, which is exported. Yellow poplar is cut for weather boarding, and for general uses. The price of the better grade is about $16 to $18 per M. at the mill. All of the oaks and most of the other species are cut into rough lumber and used locally for building purposes. The price at the mill ranges from $9 to $15 per M., depending on quality and accessibility.

CORDWOOD.

The annual cut of cordwood for shipment out of the county is about 1,400 cords, of which 1,000 cords is pine, and 400 cords is hardwood, principally oak. Pine is worth $2.50 to $3.00 per cord delivered on cars at the railroad, while hardwood is worth $3 to $4 per cord. Practically all of the cordwood exported goes either to Washington or to Baltimore.

PULPWOOD.

Scrub pine, yellow poplar and red gum, are the only species cut for pulpwood. In 1907 about 3,000 long cords of scrub pine and 500 cords of yellow poplar and red gum were shipped. The price of stumpage depends upon the distance from the shipping point and the species. The stumpage price of poplar and red gum is higher than that for scrub pine. The items making up the average cost of pulpwood, f. o. b. cars, where the hauling distance to shipping point does not exceed three miles is about as follows:

	Scrub Pine.	Yellow Poplar or Red Gum.
Stumpage	$0.60	$1.00
Cutting, peeling and piling	1.75	1.75
Hauling	1.35	1.50
Loading in cars	.20	.25
Total	$3.90	$4.50

Under the foregoing prices the pulpwood shipped in 1907 had a value of $13,500 delivered at the nearest shipping point.

RAILROAD TIES.

The cutting of railroad ties has been an important business in the county for many years. Most of the tie material has been taken out, however, and now the production is limited. The principal species used are white oak and chestnut, with a small per cent. of mixed oaks, including the black, red and spanish. First class white oak ties bring 70c. on the railroad; second class white oak 50c.; first class mixed oaks and chestnut bring about 40c. No reliable figures could be obtained for the tie production for 1907, but it is estimated at 15,000, of which 7,000 were No. 1 white oak and the balance No. 2's, mixed oaks, and chestnut.

POLES.

The only species cut to any extent for telephone and telegraph poles is the chestnut, and the available supply of that timber is about exhausted. Poles 8″ in diameter at the top end and 35 feet long bring about $5 each along the right of way of pole lines under construction. Poles 20 to 25 feet long for local telephone lines bring about $2.00 to $3.50 each delivered.

PILES.

Heretofore few piles have been shipped from the county, but under the present demand shipments are likely to increase. Oak is used almost exclusively, but only a small part is white oak, which is in greater demand for other purposes. Pin oak is the favorite oak for piling, since it meets the requirements of length and freedom from short crooks better than any other. The current prices for mixed oaks, f. o. b. cars, are as follows:

50-60 feet	9 cents per linear foot.
60-70 feet	11 cents per linear foot.
70 feet and over	12 cents per linear foot.

The specifications call for a diameter of 6″ at the top end and one of 14″ inside bark at 2 feet from the butt end.

FENCING MATERIAL.

Chestnut, red cedar and locust supply nearly all of the fencing material used in the county. With the growing scarcity of chestnut poles for rails, wire is coming into more general use. Large quantities of cedar, locust and chestnut posts are used every year on the farms and a small quantity, mostly red cedar, was shipped out during the past year.

EXPORT WOODS.

For many years timber buyers have been buying choice trees of the valuable species for the foreign export trade. The very best specimens of large walnut, poplar, hickory, white oak and ash go into this trade, which amounts to a considerable item. The prices (f. o. b.) at Baltimore, with dimensions required, are given below. All logs are measured in the round by Doyle's Log Rule:

Black Walnut.—$35 to $100 per 1,000 feet, B. M. in lengths of 10 feet and up, and of a minimum diameter of 14 inches. Same to be hewed on four sides to show a little black wood.

Hickory.—$35 per M. in lengths 10 feet and up, and 10 inches and over in diameter. Same shipped with bark on.

Poplar.—$27 per M. in lengths 12 feet and up, and 24 inches and up in diameter. Same hewed on four sides.

Oak.—$25 per M. in lengths 12 feet and longer, and 24 inches and up in diameter. Round, with bark on.

Ash.—$25 per M. in lengths 10 feet and longer, and 10 inches and up in diameter. Round, with bark on.

An estimate of the total annual wood and timber cut of the county, based on the most reliable data obtainable, indicates an equivalent of 20,000,000 board feet if firewood be included.

Transportation Facilities.

Since wood is a bulky product, its market price is determined, in a large measure, by its accessibility to shipping points and the freight charges to the markets. The county has exceptionally good

transportation facilities and good nearby markets. There are two trunk lines of railroad, and three shorter lines traversing the county, in addition to two electric lines. It has also good water transportation on the southwestern and southeastern boundaries, thus bringing all sections within easy reach of the markets. There are several good wagon roads and others will be greatly improved under the new system of State roads. Most of the roads, however, are poor in the winter season when much of the wood and timber hauling is done.

Freight rates by rail from Upper Marlboro, the county seat, to Baltimore are 80c. per ton by the carload for both cordwood and lumber. This is equivalent to about $1.20 per cord for pine, $1.60 per cord for oak, and for oak lumber about $2.20 per thousand feet B. M. The rates to Washington are about the same.

Destructive Influences.

The main causes responsible for the present poor condition of the forests are fires, browsing of animals and destructive methods of cutting.

FIRES.

Forest fires in the county for the year 1907 burned over 900 acres of woodland and caused an estimated loss of $3,600 in fences and timber burned. The loss resulting in the decreased producing power of the forest is not included; with this added the amount would be many times greater than reported. During the previous year the estimated loss was five times as great. The fire damage has been greatest over the northern and western sections of the county, where it alone has, during the past twenty years, cut down the producing capacity of the forests at least one-third.

The effects of fire are: (a) the burning of the leaves and litter on the ground which are needed to conserve the moisture, protect the seed, and to fertilize the soil; (b) the destruction of the seed, and young seedlings that have already started, and which are so essential for the renewal of the forest; (c) the burning of the cambium, or living wood of young trees, on the side most exposed to the fire, caus-

ing the bark to peel off, thus exposing the wood to decay. The tree becomes stunted, decay enters the wood and gradually works its way up into the trunk, rendering the tree practieally worthless; (d) a severe fire in the brush, left by logging operations, often kills all the trees that remain, entailing a total loss of growing stock.

Cause of fires.—The principal causes of fire are railroad locomotives, careless burning of brush, hunters, and careless smokers. Nearly all fires could be prevented with reasonable care. Under the State Forest Laws,[1] any individual or corporation maliciously, or earelessly, causing a fire that injures another's lands is liable to fine or imprisonment, or both. Since this law was enacted in 1906 forest fires have been much less frequent. By eooperating with the State Forest Wardens in suppressing fires and in bringing offenders against the law to account, the fire-damage may be greatly reduced.

Preventive Measures.—Where there are small woodlots, surrounded by cultivated land, the danger from fire is slight, but in the ease of larger tracts, especially where they are traversed by or border upon public highways, or railroads, there is considerable danger. Most fires occur during two seasons of the year, either in the late autumn after the leaves fall, or in thc early spring shortly before the new leaves appear. The best preventive measures are to keep the dead brush eleared up, particularly along the sides of the wagon roads, or railroads. Where a railroad traverses the woods, or passes along the edge of it, a fire line may be cleared along the sides of the track wide enough to eateh all sparks and hot cinders that are thrown out by the locomotives. This line may bc easily and cheaply constructed by burning the leaves and litter, rather than to attempt to rake the space clear of inflammable material. Wagon roads and wide paths through the woods often serve as effeetive barriers to the spread of fire if they are kept clear of leaves and dry brush.

GRAZING.

It is a common practice throughout the county to inclose the woodlot with a fenee, and to use it for pasture. This is a bad policy for

[1]A copy may be had on application to the State Forester, Baltimore, Md.

the reason that if the wood is thick enough (fully stocked) there will not be sufficient light for grass to grow, hence little feed for cattle. On the other hand if the wood is open enough to permit grass to grow, it is usually because the young trees have been killed out by the browsing of cattle, hence poorly stocked and producing little growth. If the wood is to be thickened up by young growth to produce a full yield, cattle must be excluded to give the seedlings a chance to start. In other words, it is out of the question to expect the woodlot to furnish pasturage and at the same time grow a full crop of timber. The killing of young growth is not the only damage.

DESTRUCTIVE METHODS OF CUTTING.

Owing to the former low prices of standing timber it was not profitable to cut any but the best trees and hence, for 50 years or more, there has been a repeated culling of the forest. At first the best of the walnut, cherry, and poplar that was most accessible was cut, then, as timber prices advanced, and logging appliances were improved, new areas were invaded and the best of the white oak was gotten out. Later the same tracts were given over to logging operations in which all good timber was cut out by portable mills. With the advent of tie cutters and buyers of telephone and telegraph poles even the smaller oaks and chestnuts have been culled from most of the stands. With the constant cutting of the valuable species the forest has largely changed from one in which the desirable kinds of trees formed the principal stand to one in which such trees have been supplanted largely by inferior ones. In other words the cutting was for immediate returns and little or no attempt was made to suppress the undesirable species and to encourage the desirable ones in the future growth. Cheap timber led to extravagant waste, so that after logging operations were over, the ground was strewn with big tree tops and brush so that the fires, which usually followed such operations, were so intense as to complete the destruction of the stand.

Forest Management.

The need of more conservative management for the woodlands of the county is emphasized by a statement of the following facts:

1. The present woodland area is not producing one half the revenue, as regards quantity and quality of produce, that it is capable of doing under judicious management.

2. A good market is certain for forest produce of nearly all kinds. Prices have nearly doubled in the past ten years.

3. The climatic and soil conditions are favorable for the growth of timber. When the forest is properly protected the natural growth is rapid.

4. The species native in the county, and already established in the forest, are mostly of the valuable kinds. Proper management will insure a greater representation of such species in the present stand and therefore greatly increase the final returns.

5. There are many small areas, either growing up to worthless brush, or exhausted farm land where agricultural crops bring but small returns, which would bring profitable returns if planted to forest trees. Valuable species for the purpose are chestnut, red oak, pin oak, yellow poplar and locust.

The object of forest management is to secure on a given area the highest forest returns in the shortest time at the least expense. The plan of procedure will differ with the type of forest to be managed and its present condition. Under past abuse, due largely to economic conditions rather than careless methods, the forests have been reduced to a much depleted condition. To restore them to a high state of productiveness, which is the business of forestry, will require careful, systematic treatment. In applying forest management the two main types—mixed hardwoods and pure pine—will require very different treatment.

Mixed Hardwoods.

In mixed hardwood stands, where the forest contains a great variety of tree species differing in relative value, the main object should be to weed out the undesirable kinds, and to encourage the best trees of the merchantable species. In the case of the farmer's

woodlot, where a relatively small area is required to produce a continuous supply of fuel, fencing and building material, the selection system of management is the most practical. Under this method the farmer "selects" and removes, from time to time, such trees as he may require for immediate needs. The success of the system will depend upon the selection of the trees for cutting and the measures taken to secure a good reproduction of desirable species. The main principles involved are: (1) Cut trees as soon after they reach maturity, or as soon thereafter as they can be used to advantage, in order to give needed room for young growth that is required to restore the forest. (2) When cutting for fire wood, stakes, etc., cut out the dead wood, the crooked and undesirable trees, to give every advantage to the young, thrifty trees of the desirable species that are intended for the permanent stand. (3) Be careful not to create large openings where no reproduction has started.

Where there is a fully stocked young stand to work with, it is usually not a difficult matter to mould it into a forest of excellent form. Whenever the trees of the desirable species are being too severely crowded by inferior ones, the latter should be cut out. This combined thinning and improvement cutting should be repeated every few years until the stand attains its height growth, when the trees left will be allowed to remain until maturity.

Where the forest has been abused by excessive and injudicious cutting, and perhaps injured repeatedly by fire, the first consideration should be to get the stand as fully stocked as possible. This may often be accomplished by natural seeding, if the woodland is protected from fire; and cattle, sheep and hogs are excluded. Where the present stand consists of only scattering trees of undesirable species, and where there is not a sufficient number of seed trees of the desirable kind to seed the land, it will probably be the best plan to cut the woods clean and plant with the kinds of trees it is desired to grow. In the case of a woodlot where clear cutting of the whole area would entirely cut the supply of wood for the farm, the area may be cut off a few acres at a time, the operations extending over a number of years, so as to have a rotation of timber crops.

PURE PINE STANDS.

The best system of management for pine land is to cut clean. Where the land is to be devoted to another crop of pine, it is generally best to cut the pine off in strips along the east side of the woods. The strip should not exceed 150 feet in width. After the first strip is cut, 2 or 3 years should elapse before the next one is cut, so as to allow ample time for the recently cut-over strip to be fully seeded from the standing trees on the windward side. By cutting succeeding strips, and giving sufficient time for each to become seeded from the adjoining woods, a new stand will be established after each cutting without expense. Where fields have grown up in dense young pine stands, and where small sized firewood can be used, it will often pay to cut out the dead trees and those that are being killed out slowly by larger overtopping trees. This will insure a more rapid growth and a better development of the trees in the stand. Since there is so little market for small wood, it will generally not be advisable to thin the stand, since it is likely to cost more than is warranted by the slight increase in final returns.

The market prices for cordwood and pulpwood are good, and will undoubtedly advance as more accessible supplies become exhausted. Even with present prices there is much of the sandy land now being cultivated with small profit, that would yield better returns if allowed to grow up in pine.

A thick stand of pine at 20 years of age will cut nearly 20 cords per acre, and will increase in growth about 1 cord per acre each year up to 35 years, when maturity is reached. With cordwood stumpage at 60c. per cord, the gross return will be $12 per acre at the end of 20 years, or $18 at the end of 30 years.

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MARYLAND GEOLOGICAL SURVEY

PRINCE GEORGES COUNTY